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ESTABLISHING A UNIVERSITY ACADEMIC HEALTHCARE INSTITUTE WITH MULTIPLE CENTERS: A CASE STUDY

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ABSTRACT

The new Health Sciences and Business Administration (HSBA) building at Valdosta State University is intended to integrate resources from the Langdale College of Business, College of Nursing and Health Sciences, and the James L. and Dorothy H. Dewar College of Education of Education and Human Services to enhance the health and well-being of our regional population through innovation, collaborative research, education, and effective healthcare delivery. Ongoing preparations to create a Healthcare Institute within this framework suggest the need for open communications, willingness to change, and political will in order to write a detailed business plan to implement such an Institute.

INTRODUCTION

Major changes in Academic Health Centers (AHCs) resulting from mergers, downsizing, and cost cutting suggest opportunities for smaller universities to play a larger role in educating, training, and researching healthcare issues [1]. The new Health Sciences and Business Administration (HSBA) building at Valdosta State University was built to house the College of Nursing and Health Sciences, Langdale College Business Administration, and with a separate and secure clinical office space for a Healthcare Clinic designed to support student practicums and community healthcare delivery services. It was envisioned that the Langdale College of Business, College of Nursing and Health Sciences, and the James L. and Dorothy H. Dewar College of Education of Education and Human Services would contribute resources to operating and staffing a healthcare clinic. Rather than operate as independent units within the Healthcare Clinic, it was thought that if existing resources could be centralized under the umbrella of an Institute, interprofessional relationships would be enhanced, resources could be shared, and costs lowered. Importantly, the clinic would serve faculty, staff and their dependents in a way that would reduce institutional healthcare insurance costs. Additionally, an operating clinic would be seen by the community as an asset to the community and as a highly visible service operation for Valdosta State University. It was also thought that the excitement of a new building would draw the collaborative spirit and support of administrators, faculty, and regional stakeholders in providing resources to support healthcare economic development in our region.

To begin planning for the Institute, The Langdale College of Business (LCOBA) provided faculty expertise familiar with Healthcare Administration, Electronic Healthcare Records, and Business plan writing with help from the Small Business Development Center (SBDC). The College of Nursing and Health Sciences would staff the Institute (Healthcare Clinic facility) with teaching faculty to support nurse practicum student training, Exercise Physiology, and an Athletic Service Lab. The College of Arts and Sciences would house their VSU Speech-Language and Hearing Clinic along with the Social Work Practice Clinic. The Institute would

act as an umbrella organization for these smaller clinics within the larger healthcare clinic. At the start, it was unclear to what extent each clinic could operate independently, how they these clinics might be managed collectively, to what extent information technology could be applied, or what the Institute business based healthcare clinic, business plan might look like. Thus, our research question is to determine what services our Institute would offer, how it would be managed, and to what extent it could be self-sufficient.

The next sections will discuss the background, healthcare business parameters, and actions taken. Preliminary results are discussed and needed future actions to gain approval for the Valdosta Institute of Interprofessional Health and Wellness.

BACKGROUND

Strategic planning for the Valdosta Institute of Interprofessional Health and Wellness began in the fall of 2013. The first order of business identified the need for a healthcare Institute and how we might establish such an Institute. Considerable work had already been done in that the Langdale College of Business had recently been approved to begin an undergraduate program in Healthcare Administration and a Healthcare Administration concentration in their MBA program. It had been determined that the healthcare field was growing and that career opportunities for our students existed. Further, the across street presence of the South Georgia Medical Center suggested future opportunities for professional training, collaborative research, as well as growing healthcare businesses in our region that would be receptive to hiring future students. The establishment of a Healthcare Institute was also consistent with university initiatives to foster regional economic growth and establishing greater visibility with the local community by delivering healthcare to underserved populations as part of the universities service mission.

It is also true that healthcare is changing because of the Affordable Care Act (ACA) and that no matter how the ACA is implemented, funded, or modified there are certain brutal facts that must be considered [2, 3]. It is clear that the healthcare financial bubble with burst, current clinical networks will not survive, and physician autonomy and organized medical staff will become less relevant. Thus, there will be a greater acceptance of business technologies and business expertise [4]. Creating a healthcare clinic in an academic setting in close proximity to an accredited business school and associated expertise is the ideal opportunity to experiment and research more effective healthcare management models.

Similar models for academic based nursing centers that typically strive to fulfill multiple purposes is our starting point [5]. Business faculty further recommended researching how other Institutes and Centers were setup and operated. We also looked at and identified other centers and Institutes that are part of the University of System of Georgia (USG) so as not to overlap functions and missions. It is also important for the long-term financial health of the institute to develop a long range strategic plan that takes into account limited space, limited size of staff, and no current endowment. A Mission Statement and organizational chart will also be required.

Ongoing preparations and planning prior to launching such an Institute suggested that open communications, a willingness to change, and political will would be needed to create a forward

looking strategic plan that included detailed business plans. There would also need to be planning for organizational and cultural change [6]. Such plans were necessary in preparation of writing a draft proposal in order to implement such an Institute. Ultimately, approval for a new Institute would need USG Board of Regents approval.

In general, planning would begin by analyzing the Institutes needs and objectives [7, 8]. The needs assessment would look at staff and faculty needs and investigate community needs and resources. If the Institute proves feasible, faculty and community involvement, along with senior-level champions would be needed to move the approval process forward. The programs scope (Mission) and organizational structure would need to be sorted out. A director would need to be chosen and the Institute program set into motion. Clearly, liability and quality go hand in hand. Cutting corners on staff quality, staffing, or the facility in general might place the institution at risk [7]. Good planning and effective communication between stakeholders is an important consideration in reducing liability, improving quality, and in moving the Institute concept forward.

Other USG Institutes and Centers

Table 1 lists USG Universities that have healthcare related programs and/or established Healthcare Institutes or Centers. It should be noted that we hoped to establish an Institute different from what might be commonly thought of in the healthcare field as we would be an academic Institute. There are many highly specialized Institutes and Centers in the healthcare field with doctors and nurses devoted to patient care. As an example, there is the “The Center for Cancer Research”. “The Center for Cancer Research (CCR) is part of the National Cancer Institute (NCI). Our mission is to inform and empower the entire cancer research community by making breakthrough discoveries in basic and clinical cancer research and by developing these discoveries into new therapeutic interventions for adults and children afflicted with cancer or infected with HIV (<http://ccr.cancer.gov/research/>).” These kinds of Institutes and Centers have different missions and are staffed by doctors and nurses who treat and manage patients in a very specialized way. Our goals were much more modest in that we intended to support faculty, staff, and dependents in a way that reduced institutional healthcare insurance costs.

The envisioned Valdosta Institute of Interprofessional Health and Wellness was needed to support nurse practicum training, Exercise Physiology, and an Athletic Service Lab for students enrolled in those programs. Further, the existing VSU Speech-Language and Hearing Clinic along with the Social Work Practice Clinic would be co-located in the healthcare clinic space as part of a one stop healthcare experience for our targeted communities. The Langdale College of Business Healthcare Administration students would be able to observe the management and see the actual operation of a Healthcare Information System. Faculty would be encouraged to experiment with new ideas, engage in interdisciplinary research, and collaborate with stakeholders in support of regional economic development. The envisioned model was clearly different than traditional healthcare delivery models both in the way we imaged such an integrated facility might work and in the way we wanted to enhance student learning.

Table 1 reflects programs in Healthcare Administration, Nursing, Exercise Science, Social Services, rural health, urban health, and other programs associated with universities belonging to

the University System of Georgia. Column one is the name of the USG University. Column two is that University College followed its healthcare programs within that college related to the type of Institute we wished to establish. Columns four and five identify whether or not that university has an Institute or Center related to healthcare.

Our initial strategic planning was to identify healthcare areas where we could be different, add value, and not compete directly with other USG schools. We also looked at colleges with similar academic programs to identify any overlaps. While there seem to be some overlaps none seem to be significant. We must also take into account differences between similarly looking programs and size of programs. For instance, there is a shortage of nurses and nursing faculty. While other colleges may have nursing programs, they do not compete directly with Valdosta State University (VSU) and the small number of graduates from any program is in high demand. The same could be said for programs in social work, speech disorders, athletic training, and kinesiology.

The closest USG competitor to VSU is Georgia State University. The Institute of Health Administration has academic programs in Healthcare Administration and Health Informatics. The Georgia State Programs seem to be focused within the greater Atlanta area with no obvious outreach or service mission identified. While other Master of Healthcare Administration Programs exist, like Clayton State University, their programs are not associated with Institutes or centers.

TABLE 1: USG Healthcare Institutes and Centers

| Centers, Institutes, and Colleges Established at USG Institutions Related to Healthcare | Colleges with Healthcare Programs | College Program | Institutes related to Healthcare | Centers Related to Healthcare |
|---|---|--|----------------------------------|-------------------------------|
| Clayton State University | School of Graduate Studies | Master of Healthcare Administration | None | None |
| Columbus State University | College of Education and Health Professions | School of Nursing | None | None |
| | | Counseling, Foundations & Leadership | | |
| | | Health, Physical Education, and Exercise Science | | |
| | | Health & Physical Education Nursing | | |

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|---------------------------------------|--|--|---------------------------------------|---------------------------------------|
| | Graduate School | Healthcare Informatics Certificate | | |
| Georgia College & State University | College of Health Sciences | Master of Education in Kinesiology: Health Promotion | Center for Health and Social Services | None |
| | | Masters and Doctorate in Nursing | | |
| Georgia Institute of Technology | None | None | None | None |
| Georgia Southern University | College of Graduate Studies | Public Health | Rural Health Institute | None |
| | College of Public Health | Nursing | | |
| | | Master of Healthcare Administration | | |
| Georgia Southwestern State University | School of Nursing | Master of Science in Nursing | None | None |
| Georgia State University | College of Business Administration | Masters in Health Administration | Institute of Health Administration | Health Information Technology |
| | | Health Informatics | | Health Services Research |
| | School of Public health | Health Management and Policy | | Partnership for Urban Health Research |
| Kennesaw State University | College of Continuing Education and professional education | Healthcare Certificates | None | None |
| University of North Georgia | College of Health Sciences & Professions | Nursing | None | None |
| | | Physical Therapy | | |
| Southern Polytechnic State University | None | None | None | None |
| University of Georgia | The Graduate School | Masters of Public health | | |

| | | | | |
|----------------------------|--|---|-----------------------------|----------------|
| | College of Arts and Sciences | | Institute of Bioinformatics | None |
| University of West Georgia | | None | None | None |
| Valdosta State University | College of Business | MBA /BS Healthcare Administration | Planning Stage | Planning Stage |
| | College of Nursing | MS in Nursing BA in Athletic Training BS in Exercise Physiology | | |
| | James L. and Dorothy H. Dewar College of Education of Education and Human Services | BS and MS in Communication Disorders BS in Kinesiology MSW in Social Work | | |

Thus, the first pass in looking at USG Universities is that the Proposed Valdosta Institute of Interprofessional Health and Wellness might fit well into a niche market in the South Georgia region. There is little direct competition from USG universities and the uniqueness of combining resources from different VSU colleges suggests distinctive opportunity for innovation, collaborative research, and broader shared educational opportunities to gain in-depth knowledge of the healthcare field.

Establishing Institutes and Centers

Two issues arose in the discussion of how to establish an Institute. One issue was establishing a 501 (c) (3) tax exempt status for the Institute. Under IRS rules, educational organizations are a tax-exempt nonprofit organization. The reality was that, any Institute, established under an existing university, would be tax exempt as long as it is governed and financially controlled by the managing institution. The real issue was political. Some Institutes are established separately from the parent organization with separate governance and financial accountability to avoid conflicts of interest with the parent organization. Institutes as part of their mission may write reports, develop political views differing from established norms, or except monies from organizations with contrary agendas. The parent organization might then be placed in an awkward position, making them politically or financially vulnerable. By establishing an Institute separate from the University, the Institute management team is free to operate independently within the guidelines of their charter. Fundraising organizations who donate monies to universities are one example. Since our envisioned Institute closely supports the educational mission of the university, there was no thought given to independent governance and that the healthcare clinic was operating within a university building really made no sense. An Institute operating independently would need to raise funds to support all salaries, overhead and operations.

Secondly, we wanted to understand the difference between a Center and an Institute. The USG, INFORMATION ITEM, BOARD OF REGENTS, 11/1979 provided the following definitions that we used as guidance:

Research Centers

“A research “center” provides an organizational base for research in a given academic area or closely related areas. It often provides a vehicle for interdisciplinary research in a given area involving faculty and students from a variety of internal administrative structures. A center may be involved in offering continuing education activities related to its area(s) of interest. The center structure may facilitate efforts of the college or university to obtain extramural funding in specific areas. It serves as a formalized link between the academic community and the professional community in the area(s) of focus. A center, however, is not an autonomous structure within the internal statutory organization of a college or university. It is administratively most often an appendage of one of the traditional administrative structures, such as a department. A center is not involved in the independent offering of credit course or degree programs.”

Institutes

“An “institute” shares a center’s focus on research, provision of opportunity for interdisciplinary activity, involvement in continuing education activities, value in facilitating efforts to obtain extramural funding, and service as a link between the academic and professional communities. An institute, however, is a far more formalized structure and may be equivalent to an autonomous unit within the internal structure of the college or university such as a department, division, school or (university level) college. Unlike a center, an institute may offer credit courses and degree programs.”

MISSION STATEMENT AND VISION

We identified early on that we desired a multidisciplinary institute committed to engaging our students, faculty, local professionals, and our regional community in the mission of the Valdosta Institute of Interprofessional Health and Wellness. In general, we visualized an Institute that supported delivery of healthcare to divergent and underserved populations, a service orientated environment, a place where creative healthcare solutions could be explored, opportunities for students to explore careers in healthcare, promotion of professional educational initiatives, and exemplary facilities to train and teach students. We also knew that we would eventually need a business plan detailing how the Institute would operate. However, it was necessary to write a mission statement first that would clearly state what the Institute would or would not be.

A mission statement committee was formed. The draft mission statement was shared with the larger committee; change recommendations were made and accepted. The recommended Mission Statement and Institute Vision are as follows:

VALDOSTA INSTITUTE OF INTERPROFESSIONAL HEALTH AND WELLNESS

OUR MISSION

The mission of the Valdosta Institute of Interprofessional Health and Wellness is to enhance the health and well-being of our regional population through innovation, collaborative research, education, and effective healthcare delivery.

OUR VISION

A multidisciplinary Institute committed to engaging students, faculty, professionals, and our regional community in the successful support of:

- delivering effective healthcare to divergent and underserved populations
- creating a teaching/service environment for the health professions in which innovative and creative healthcare solutions are explored
- learning environments that inspire students to pursue careers in the healthcare industry
- public and private collaboration in generating evidence-based solutions to healthcare issues
- promoting professional education initiatives that prepare practitioners for ongoing changes and challenges to the healthcare industry

Having a draft Mission Statement and Vision allows all stakeholders to focus on the mission and not be distracted by mission creep. It can also be used as a tool to recruit advisory board members and begin soliciting funds in support of a new and forthcoming Valdosta Institute of Interprofessional Health and Wellness. The existence of an advisory board and funds would be necessary in writing an effective business plan. Having a name and mission gives the concept substance and form, making the Institute conception closer to a reality.

INSTITUTE ORGANIZATIONAL CHART

Having developed a mission statement and vision an organizational chart was developed prior writing any draft business plans. Successful Institutes require advisory boards and chains of command that affect reporting requirements, financial controls, and job assignments. In discussing different organizational requirements several issues came to the forefront for the medical practitioners. It was decided that a Director position would coordinate business processes, manage the facility and any staff, and coordinate with stakeholders. But, the director would not have line control over medical or teaching decisions. As a result, it was decided that Nursing, Social Services, Exercise Physiology, Communication Disorders, and Athletic Training would operate as their own Centers and report to the director for administrative needs while retaining purview over medical matters. Other Centers to support Health Informatics and Interprofessional Research would also be established.

By operating as separate Centers but under the Institute umbrella, it might be easier to manage and identify and manage business requirements. Further, there appeared to very different business models for the clinics that were already established with differing accreditation requirements and standards for each academic unit. By not integrating totally at the beginning,

the possibility of being up and running sooner by creating fewer issues and more cooperation from stakeholders. It was understood by stakeholders that the Institute would be governed by a Healthcare Information System and that all Centers would use the same Electronic Healthcare Record (EHR) Management System [9].

Figure 1: Draft Institute Organizational Chart

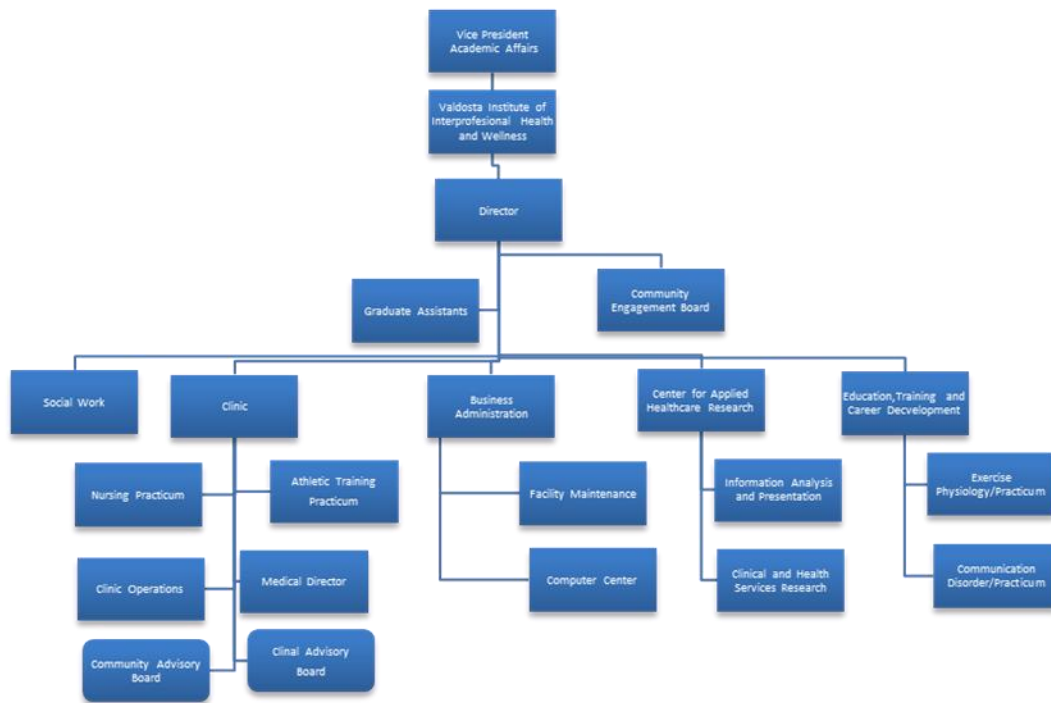


Figure 1 is the draft organizational chart for the Valdosta Institute of Interprofessional Health and Wellness. It includes the advisory board, operating centers, business units, and includes the position of Director. The director reports to the Vice-President for Academic Affairs. One additional unnamed advisory board meets annually to review the purpose and mission of the institute. This board is not made up of the same people as the community advisory board or medical review board but does come from community members. The outcome is to recommend whether the institute should be chartered for another year. It should review the financial statements, training records, publications records, etc. to evaluate whether or not the Institute is meeting its mission, performance goals, and community service mission objectives. This ensures that the Institute can be ended when its time is over or it is shown to be financially unsustainable [5, 10].

An important consideration in developing the mission statement and organizational chart was the recruitment of stakeholders for the Valdosta Institute advisory boards [11]. The establishment and assistance of the board would be required to finalize the business plan and garner initial financial support for the Institute. Being able to show working documents would demonstrate to the community that the university was truly engaged in the community's well-being and that

their input was truly needed. It should also be recognized that recruiting a board is time-consuming and that members of such an advisory board are recruited by university leadership from recommendations made by the Institute development committee.

BUSINESS PLANS

The next step after drafting a mission statement and organizational chart was to ask each prospective Center to develop a business plan for their unit. The director of the SBDC provided a business plan outline and was available for assistance as needed. This stage of Institute planning started off slow as few of our members had the experience or business training needed to write an effective business plan. It was also discovered that there were basic business parameters that individual centers had not thought through or been made aware of that needed to be answered in order to structure individual Center business plans [12].

The first issue was self-sufficiency. Typically, you are given a budget and then you manage your budget accordingly. The parameters that you work under are determined by the numbers of available professors, classroom space, and student enrollment. An Institute needs to be self-sufficient in that it must either show a profit or break even. This requires a different budgeting model and thought process than committee members were accustomed to. Even though there were expectations of University financial support, they were being asked to consider how to manage money coming in and going out. For instance, if you run a clinic that serves community members, they will be asked to use insurance to pay for your clinic services. If you conduct professional training, where does this money go and how faculty are reimbursed for their time. Even though the Institute would be using university office space, the objectives and mission of the Institute would be in addition to and outside of the teaching missions of the associated Colleges.

An efficiently run clinic can free up staff, lower costs, and take advantage of advanced business technologies and professional expertise. To this end, clinics should be modeled [4] based upon user defined parameters including;

- Composition of the medical staff;
- Number of registration windows;
- Number of check-in rooms;
- Number of examination rooms;
- And, number of specialty rooms.

These parameters can be varied to establish a range of clinic effectiveness measurements that impact clinic profit (i.e. clinic revenue minus clinic expenses), patient satisfaction, and medical staff satisfaction. For example, a clinic configuration may maximize profit by increasing patient wait times in a way that decreases patient satisfaction. Or medical staff may want to spend more time with patients but at the expense of profit. These factors and relationships must be considered in any business plan.

The salary of the director, any support staff, and the additional cost of operations would require a separate accounting. Professors assigned to the Institute to support the clinic operations would be reimbursed separately from assigned time when they were teaching in the institute as part of

an assigned course when doing student training. The key point here is that running a clinic is a separate endeavor from the teaching mission of the College.

As such, scheduling became a concern. A clinic runs on set predetermined operating hours. Committee members as part of their business plan would need to obligate faculty to specific clinic hours. That is, the staffing of the clinic would have a higher priority than other faculty requirements. The clinic would open at a set hour and close at a set time so that scheduled appointments could be made. This is a different kind of scheduling than committee members were accustomed to in comparison to scheduling classrooms and instructors. Our institution was starting a new organization with different operational parameters prior to the doors opening than was typical. This proved to be an impediment. Without some concept of operating hours committee members from each of the Centers were unable to create balance sheets, determine resources, and consider staffing levels. In retrospect, we assumed individual centers would determine their own operating hours and we would coordinate schedules from the business plan recommendations. This was not the case.

In the end, the committee determined for planning purposes, the healthcare clinic would be open 20 hours a week, Monday thru Friday, 8 AM to 12 PM for the first two years. The clinic would begin serving VSU faculty and staff first, gradually expanding in the second year to spouses and in their year families. Committee members were asked to staff the clinic based on these operating hours. It was left to the individual centers to determine how many patients they could see per day based on current staffing and resources.

The Centers were to assume that the clinic was operating separate from University funding and to base their budget projections on a break-even budget. This meant they had to look at what portion of the day, which faculty and staff were assigned to the college and when they were working in the clinic. They were asked to calculate a range of staffing options, assume the smallest number of patients you might see in a given 4 hour work day versus the maximum number of patients you might see based on available office space. Further, they needed to think through what resources would be needed for each scenario?

A third parameter, parking, became an issue. During discussions concerning operating hours, one physical limitation made apparent was the availability of parking spots near to the clinic. How many cars per hour could we park in the vicinity of the clinic? Given the clinic was located in the same building as student classrooms and faculty offices, it was clear we might have a problem. Given that the clinic operations were beginning small, this was not a major issue but as services expanded in future years to meet demand and utilize the full potential of the available clinical office spaces, we might have a limitation to future growth.

BUSINESS PLANNING RESULTS

Committee members have submitted their business plans but they have not been fully accessed nor combined into an integrated Institute business plan. It is expected that an Integrated Institute business plan will be developed in the near future. It is also expected that once an integrated draft business plan is written, it will be shared with the advisory board and university

administrators. Clearly a finalized business plan and finalized Institute proposal will go through much iteration and consider factors we have not currently considered.

Preliminary results from reading the draft business plans from the five small Centers suggest a lack of understanding in how to write a basic business plan. Draft business plans were written out cookie cutter style with little revision or modification to the business plan template. There was insufficient detail that explained how an 8:00 AM till noon healthcare clinic might operate and how costs might be assigned. It is clear that general business plan expertise is needed to take the initiative to develop a comprehensive schedule and financial plan based on the rough inputs from the draft business plans. From these rough inputs, a comprehensive Institute business plan will be devised whereby it is anticipated that several additional iterations of the master plan will be shared. Centers may then look at their part of the plan and suggest changes. The difficult part will be to model a plan that will break-even financially based on the scheduled hours and use of resources.

LIMITATIONS AND CONCLUSIONS

It is clear that the committee went through the forming, storming, norming, and performing stages of Bruce Tuckman's team development model. We have yet to adjourn. While all members of the committee are enthusiastic, it took time to develop the trust between business units to be able to share information and offer advice and recommendations. There was some mistrust of the College of Business at the beginning by healthcare professionals that the business professionals didn't understand patient care or how healthcare training and education really worked. After a time, we moved from cooperation to collaboration in developing business plans. We believe this process was helpful in getting us where we needed to be and will be beneficial to the Valdosta Institute of Interprofessional Health and Wellness when the Institute opens. There is now trust between committee members that as the business plans are revised, the healthcare viewpoint will be reflected in how the business operates.

There are a great many different healthcare Institute organizational models, There is no one right way and it seems every university organizes their Institutes and Centers based their specific needs. Future research might classify each of these different models into broad categories as a way to better understand how our Institute might be made more effective.

Table 1 only considered USG universities as competition. Future thought must be given to other regional schools not in the USG who may develop their own healthcare Institutes and compete for resources. Further, while the focus of our Institute is on regional economic growth, we must be cognizant of National and International initiatives.

We found that the sharing of information between groups was slow at first. Trust needed to be developed overtime and senior leadership was required to remind committee members that this initiative was going to happen and that time was a factor. It was also clear, that senior leadership did recognize that detailed planning and collaboration was going to be needed and that if more time was needed we could have it. It is equally clear that there is a place for business faculty in the Institute planning process and in operating the clinic. We see the same dynamics happening in our small healthcare clinic in balancing financial realities with patient care. There is also

understanding from the medical professionals that their world is changing and that they need business assistance in changing how they work and train.

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DECREASING AMBIGUITY IN RESILIENT SUPPLY CHAINS. A GUIDELINE OF ORGANIZATIONAL COMPLEXITY FOR CONTEMPORARY SUPPLY CHAINS

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ABSTRACT

The paper seeks to investigate ambiguity as a driver of organizational complexity in resilient supply chains. The theoretical part of the paper is followed by the findings of empirical study demonstrating the maturity of contemporary supply chains to decrease ambiguity. The conclusions of the study offer some insights into the characteristics of analyzed supply chains and provide a practical guidance to operate as a resilient organization.

RESILIENT SUPPLY CHAIN AS A COMPLEX ADAPTIVE SYSTEM

The etymology of the term “resilience” is diverse. It was adopted from psychology and sociology for the purpose of supply chains and is directly related to the issue of social sensitivity, ecology, mental resistance (Ponomarov and Holcom 2009). Consequently, several definitions of a resilient supply chain exist and lend significant characteristics from resilience interpretations offered by the mentioned disciplines. The interdisciplinary character of the concept, as well as the difficulty of the research object, contribute to the fact that the problems of resilient supply chains, although interesting in their theoretical foundations and inspiring in respect of empirical research, have not been described and examined in a synthetic study yet.

Resilient supply chain is characterized by the ability to adapt to unforeseeable difficulties and return to its initial state (Coutu 2002). According to Christopher and Peck (2004), and Wildavsky (1991) resilience in the context of supply chain refers to the ability of returning to the initial state or transition to another state, more desired after the occurrence of a specific disruption. This is paralleled with the observation by Chakravarthy (1982), Valikangas (2010), Mallak (1998), Horne and Orr (1998) that resilience is the ability of a supply chain to adapt, regain lost strength and provide reactive response to the requirements of the environment.

Resilient supply chains are open systems of interconnected elements, such as suppliers, third parties, customers, and internally include other sub-systems (Gregory and Rawling 2003; Otto 2003). The openness of the system and the permanent interaction with its environment as outlined by Fisher (1997), Lee (2002) and Christopher et al. (2006), leads to the conclusion that a resilient supply chain is induced by the system's environmental conditions. Therefore, the increase of external complexity is often inherently interrelated to the increase of internal complexity of a supply chain.

The increase of internal complexity contributes to establish a non-linear and non-equilibrated structure of resilient supply chains delivering non-deterministic outcomes (Cilliers, 1998; Boisot and Child, 1999). This is also confirmed by Choi et al. (2001), who highlight that supply chains are complex web of changes, coupled with the adaptive capability of organizations to respond to such changes. In this vein, Rochlin (1989) mentions about "epistemic networks", and Bourrier (1996) describes latent networks in order to highlight when disruptions get outside of normal operational boundaries and the group of companies self organize into ad hoc networks with no formal structures. Therefore, supply chains are challenged to reduce their internal complexity to limit the negative effects on performance as well as to maintain a sufficient gap between external and internal complexity.

The complexity of resilient supply chains is mostly dependent upon positive and negative feedback loops which draw on systems thinking and provide several implications for breaking out of reactive mindset that comes inevitably from a simple linear thinking.

The concept of feedback means any reciprocal flow of influence. In other words it posits that each influence is both *cause* and *effect* and nothing is ever influenced in just one direction (Thun and Hoenig 2011). Instead of direct cause and effect relationship one should see relationships in a particular indirect sequence. Consequently, it is important to see reality systematically as circles of influence rather than straight lines (Senge 2004). Every circle tells a story showing how the structure creates a particular pattern of behavior or, in case of a complex structure such as resilient supply chains, several patterns of behavior, and how that pattern might be influenced (Senge 2004). The feedback loops are fundamental components of adaptation to, evolution and co-evolution with environment (Kaufmann, 1995; Richardson 2008). However, these adaptive and evolutionary processes require gathering, processing and use of information (Robertson 2004). This is confirmed by Gell-Mann (1994) who argues that complexity organization acquires information about the systems constituting its environment and information about the consequences of its own interaction with those systems.

Therefore, the concept of feedback refers to the process in which information about the outcomes of an action is fed back into decision making process in resilient supply chains in order to affect the next action. The negative feedback denotes that information about a gap between expectation and outcome is fed back to dampen deviations from the expectation. The positive feedback means to use information to amplify the gap between expectation and outcome (Stacey 1996). Using information in both types of feedback is a critical issue to overcome ambiguity, and thus simplify internal complexity of resilient supply chains.

AMBIGUITY AS A DRIVER OF ORGANIZATIONAL COMPLEXITY IN RESILIENT SUPPLY CHAINS

One of the crucial components of resilient supply chains is ambiguity. It is related to the available information regarding the business environment and the internal flow of information in supply chains. Ambiguity broadly covers the richness, predictability, accuracy and availability of information (Woodward 1993). On the other hand, Maznevski et al. (2007) argue that ambiguity is a result of excessive information with less clarity on how to interpret it and apply in the decision making process. However, Daft and Weick (1979) notice that managers are forced to “wade into the ocean of events that surround the organization and actively try to make sense of them”. Woodward (1993) proposes to measure ambiguity in terms of information that is absent or present. It can be further recognized by exploring if the information has a factual or conjectural character, if its form is qualitative or quantitative, if it is vague or precise, static or dynamic. This all affects the comprehensiveness, consistency and accuracy of the information. In a wider perspective, decreasing ambiguity is critical for a collaboration in resilient supply chains, as it may improve organizational top line as well as the bottom line (MacCormack and Forbath 2008). It may be argued that in order to overcome ambiguity the links in resilient supply chains have to intensify an on-line transfer of undistorted information from one source to all supply chain links (Comfort 1999). The advantage of such solution is the ability to share many different data, without modification. It means that for example the information about customers’ demand, which is transferred among supply chain’s partners is real, updated and guarantee an appropriate basis for the decision making process.

However, although supply chain links share the information, only few of them actually collaborate to create a joint-actions. This is consistent with the study of Terwiesch et al. (2005) who found that when individual forecasts are shared and demand is not realized as planned, the first link penalizes other link for unreliable data by providing lower service levels, while the second link penalizes the first one, that have a history of poor service, by

providing them with overly inflated data. It is a vicious circle which does not benefit the supply chain.

It should be highlighted that ambiguity, and thus complexity may be overcome not only by an effective and efficient transfer of information but also by the transfer of knowledge, which refers directly to the concept of the learning (Stacey, 1996). In resilient supply chains, a third learning loop should be particularly mentioned. It manifests itself in the form of 'collective mindfulness' as members of a resilient supply chain discover how they and their predecessors have facilitated or inhibited learning, and produce new structures and strategies for learning (Stacey 2011). Following the view of Batesson (1981), the third learning loop may be referred to as a process learning which denotes 'learning to learn'. A very good example of practical application of the third learning loop in a resilient supply chain of Toyota is described by Nishiguchi and Baudet (1998). They investigated how intensity of information and knowledge exchange coupled with in a long-term collaboration enabled to overcome complexity. The supply chain of Toyota was able to respond effectively on a sudden and unpredictable disaster caused by a fire which affected one of the most trusted supplier. It was the sole source for proportioning valves, a small but crucial break-related part used in all Toyota's vehicles.

Drawing on these findings, one of the most important requirements to overcome increasing complexity of resilient supply chains is to make the flow of information and knowledge more transparent. Following the opinion of Lamming et al. (2001) transparency is a two-way exchange of information and knowledge between supply chain partners. Based on the Supply Chain Resilience Framework of Pettit et al. (2013) the transparent flow of information and knowledge concerns many dimensions including collaborative decision making process, exchange of technical know-how, using the expertise to rapidly respond to changes, quick application of newly obtained knowledge, using technological knowledge to understand innovation activities.

The transparent flow of information and knowledge builds trust between supply chain members (Rawlins 2008), provides a free access to read and write a shared data, increases efficiency as a data is entered only once and by the person with the most accurate information. In this vein, Zhang et al. (2006) maintain that transparency has a positive influence on a customer satisfaction.

METHODOLOGY

Data collection and sample

In order to investigate the level of ambiguity and characteristics of operations performed in contemporary supply chains, the fifth release of the questionnaire developed by the Global Manufacturing Research Group was used. It consisted of several sections examining, besides general demographics, such aspects as: competitive goal measurement, internal manufacturing practices, innovation, supply chain relationships and management, and facility culture dimensions. The whole questionnaire was updated with new variables, as compared to the previous versions of the questionnaire, and contained several hundreds of measures which provided a database extremely rich with information. However, there is no single meta-theory for developing the questionnaire, instead many general aspects of operational practices are the subject of investigation.

For the purpose of the research presented in this paper, a group of variables has been selected based on its relevance for the research problem. Firstly, the number of 18 variables using 7-point Likert scale was a subject of the analysis. The variables investigated several dimensions of the transparent flow of information which foster a responsive, adaptive behaviour among organizations in order to get them to create a shared vision (Comfort 1999). In the same vein, Weick et al. (1999) and Horne and Orr (1998) want to enable an organisation to maintain a shared vision among its constituent parts during disruptions which may include common understanding the same concepts and activities which are best for the relationships, common objectives and visions, common language and codes, common values and culture, similar behavioral rules and norms. The variables also investigated the flow of knowledge among suppliers and customers, such as amount of technical know-how obtained from the partner, response to technological changes in the industry, the way the key partner's technological knowledge has improved the activities.

In addition, a large portion of variables, gathered in a survey characterized the profile and nature of operations performed in the analyzed supply chains. The measures were filled in directly (e.g. weight percentage, number of days, share in % etc.) by the respondents.

The sample employed for this research was collected between 2013 and 2014 in Europe, North America, Asia, Australia, and consisted of 522 supply chains.

The analyzed organizations are quite diverse regarding their size. The share of 29% of the sample is represented by small companies, the group of 42% is medium, whereas the share of 28% of the sample is constituted by large companies. The sample consists of organizations

from Croatia (22%), USA (18%), Poland (15%), Vietnam (15%), India (11%), Hungary (7%), Ireland (6%) and Australia (6%).

The majority of surveyed companies operate in food industry (13%), followed by firms fabricating metal products (11%), manufacturing rubber and plastic (9%), operating in electronic and other electrical equipment industry (9%), manufacturing apparel and chemicals (6% each). Each of two sectors of lumber and wood products, as well as industrial and commercial machinery occupy 5% of the sample. The other industries are also represented in the sample but with a much smaller share. It is important to note that companies from other miscellaneous industries occupy 10% of the total sample.

The study was conducted internationally with diverse methods of data collecting. The prevailing forms of research were on-site personal interviews conducted by students related to course work or by lecturers themselves and telephone, mail or internet surveys. When the survey was completed, the person responsible for data gathering in a particular country collected all country data, conducted initial data analysis, screened and eliminated the observations with the missing values. Then, the obtained data from all participating countries was centrally gathered in one common data base.

It may be assumed that a large part of the sample was drawn at the convenience of interviewers and thus a non-probability sampling method was employed. A non-probabilistic extraction of the data set means that the examined companies were not a subject of random selection and, in the light of the results, the items included in the questionnaire are not stochastic variables. It means that a descriptive (not a stochastic) approach was employed in the study. Although the research sample of 522 organizations is relatively large in its size, the obtained conclusions can by no means be generalized to the entire population of companies in the analyzed industries. As the study is in the initial stage, its findings indicate only certain tendencies and may be used for the further in-depth research.

Research methods

In order to explore the level of ambiguity and characteristics of contemporary supply chains, a two step statistical analysis was undertaken. In the first step, a portion of variables were reduced through Principal Component Analysis (PCA) in order to highlight the main underlying multi-item constructs reflecting major dimensions of ambiguity. In order to perform the analysis Varimax Rotation was employed. PCA was performed to structure the collected information and the Varimax Rotation was employed to reduce multicollinearity

among variables. The factor analysis was performed on 18 variables measuring the level of ambiguity.

The inspection of anti-image correlation matrix indicated that a measure of individual sampling adequacy is above a nominal cut off point of 0.5 for all 18 variables. It suggests that the analysis showed a clean factor-loading pattern with minimal cross-loadings and high loading on the one construct factor. The results of factor analysis revealed a following three-factor solution, covering a total of 18 variables – Table 1:

Table 1. The structure of the obtained factors.

| <i>Factor loadings</i> | | | |
|--|---------------|----------|----------|
| <i>Extraction: Principal Components Analysis (PCA) with Varimax Rotation</i> | | | |
| <i>Definition of the factor</i> | <i>Factor</i> | | |
| | <i>1</i> | <i>2</i> | <i>3</i> |
| <i>Your plant and its external partners have a common understanding about what activities are best for your relationship</i> | | | .761 |
| <i>Your plant and its external partners have common objectives and visions</i> | | | .790 |
| <i>Your plant and its external partners use a common language and codes (e.g. special vocabulary, abbreviation, and technical terms)</i> | | | .740 |
| <i>Your plant and its external partners have a common understanding about the same concepts (e.g. good, fast, cost, quality)</i> | | | .782 |
| <i>Your plant and its external partners have similar behavioral rules and norms</i> | | | .818 |
| <i>Your plant and its external partners have common values and culture</i> | | | .712 |
| <i>You are able to obtain a tremendous amount of technical know-how from your suppliers</i> | .751 | | |
| <i>You rapidly respond to technological changes in your industry by applying what you know from your supplier</i> | .793 | | |
| <i>As soon as you acquire new knowledge from your supplier, you try to find applications for it</i> | .777 | | |
| <i>Your key supplier's technological knowledge has improved your innovation activities</i> | .868 | | |
| <i>Your key supplier's technological knowledge has reduced the uncertainty of your innovation activities</i> | .825 | | |
| <i>Your key supplier's technological knowledge has helped you to identify new innovation activities that would otherwise have gone unnoticed</i> | .829 | | |
| <i>You are able to obtain a tremendous amount of knowledge about your product from your customers</i> | | .744 | |
| <i>You rapidly respond to technological changes in your industry by applying what you know from your customer</i> | | .816 | |
| <i>As soon as you acquire new knowledge from your customers, you try to find applications for it</i> | | .734 | |
| <i>Your key customers' technological knowledge has enriched your innovation activities</i> | | .858 | |
| <i>Your key customer's technological knowledge reduced the uncertainty of your innovation activities</i> | | .801 | |
| <i>Your key customer's technological knowledge identified new innovation activities that would otherwise have gone unnoticed</i> | | .777 | |
| <i>Cronbach's alpha coefficients</i> | .075 | .073 | .071 |
| <i>Eigenvalues</i> | 8.19 | 2.31 | 2.05 |
| <i>% total variance explained</i> | 24.37 | 23.24 | 22.18 |
| <i>Cumulative % variance explained</i> | 24.37 | 47.62 | 69.80 |

Factor 1: Transparency of the flow of information between supply chain partners (common understanding what activities are best for the relationships, common objectives and visions, use a common language and codes, common understanding about the same concepts, similar behavioral rules and norms, common values and culture);

Factor 2: Transparency of the flow of knowledge with suppliers (amount of technical know-how obtained from the supplier, response to technological changes in the industry by applying what you know from your supplier; acquiring new knowledge from the supplier, key supplier's technological knowledge has improved the innovation activities, reduced the uncertainty of the innovation activities, helped to identify new innovation activities that would otherwise have gone unnoticed);

Factor 3: Transparency of the flow of knowledge with customers (amount of technical know-how from the customer, response to technological changes in the industry by applying what you know from your customer; acquiring new knowledge from the customer, key customer's technological knowledge has enriched the basic understanding of the innovation activities, reduced the uncertainty of the innovation activities, helped to identify new aspects of innovation activities that would otherwise have gone unnoticed).

The obtained factors explain 69.8 percent of total variance. The Cronbach's alpha coefficients were calculated to check the internal consistency of extracted factors. Alpha score of transformed variables in all instances is above the nominal cut-off point of 0.7. Considering the rule provided by George and Mallery, the obtained results of alpha coefficients suggest a good internal consistency of those three extracted constructs (George and Mallery, 2003).

The second step of the analysis was the classification of the sample into homogenous groups through cluster analysis. It enabled to investigate the level of organizational complexity through ambiguity and the major characteristics of the clusters. The criterion for classifying the sample into clusters were the three factors extracted in the previous step of the analysis which measured the level of ambiguity.

In order to conduct a cluster analysis, a two-step approach proposed by Ketchen and Shook (1996) was employed. At first in order to determine the number of clusters a hierarchical cluster analysis with Ward's partitioning method and Euclidean distance (Sagan, 2003) was performed. The Ward's method attempted to minimize the sum of squares of any hypothetical clusters, which can be formed at each step. In the result of the hierarchical cluster analysis three clusters were obtained. The desired number of k-clusters was determined by the link between the increase of the agglomeration coefficient and the necessity of reducing the

number of clusters. Secondly, the number of clusters was used to perform K-means cluster analysis to assign each case to the appropriate cluster. The criterion of the cluster membership was the minimal Euclidean distance between each case and classification center represented by centroid (cluster center). Additionally, the results of K-means cluster analysis was compared with the class assignment obtained from the hierarchical cluster analysis. On the basis of the results of two partition methods the contingency table was constructed and Rand index calculated. The measure of agreement showed that 79 percent pairs of objects are placed in the same class. It means a high level of agreement and confirming the correct choice of K-means cluster analysis as the leading clustering method (Krieger and Green, 1999).

CLUSTER PROFILING – THE LEVEL OF AMBIGUITY AND CHARACTERISTICS OF ANALYZED SUPPLY CHAINS

The groups of supply chains obtained through the cluster analysis were a subject of cluster profiling. It yielded a structure of clusters based on the constructs used as clustering criteria. The results of the cluster analysis in terms of discriminant variables are shown in Table 2.

Table 2. Cluster means* based on the level of ambiguity (average score).

| | <i>Definition of factors</i> | <i>Factor scores</i> | | |
|-----------------|--|----------------------|---------------|-------------|
| | | <i>1</i> | <i>2</i> | <i>3</i> |
| <i>Factor 1</i> | <i>Transparency of the flow of information between supply chain partners</i> | <i>-.286</i> | <i>-.173</i> | <i>.239</i> |
| <i>Factor 2</i> | <i>Transparency of the flow of knowledge with suppliers</i> | <i>-1.419</i> | <i>.006</i> | <i>.566</i> |
| <i>Factor 3</i> | <i>Transparency of the flow of knowledge with customers</i> | <i>-.504</i> | <i>-1.014</i> | <i>.526</i> |

* cluster means are based on factor scores

In order to determine whether supply chains in the zones are different regarding the level of ambiguity ANOVA analysis has been performed. The three groups show significant differences ($p < .001$) in the three factors.

The first cluster contains only 19 percent of the research sample and indicates a very negative opinion on transparency of the flow of information and knowledge among supply chain links. Two first factors indicate the lowest scores in the first group, whereas the third construct does not show the smallest value, however its score is still negative. The findings for the first cluster suggest that the level of ambiguity in this group of supply chains is significantly high.

Cluster 2 includes 34 percent of the cases. The organizations of the group report a moderate level of ambiguity regarding the average scores indicated by three factors. The last group – cluster 3 contains the highest share of 47 percent of companies in a sample. This group has a positive attitude to ensure transparency of the flow of information and knowledge in their supply chains as the average scores of three factors indicate the highest values. It suggests that the level of ambiguity is the lowest in this group of supply chains.

The comparison of the level of ambiguity gained by the examined clusters of supply chains suggest that group 1 can be defined as ‘a high-ambiguity cluster’, group 2 may be called as ‘a medium-ambiguity cluster’ whilst group 3 can be described as ‘a non-ambiguity cluster’.

Table 3. The nature of operations in three clusters

| Characteristics | | high-ambiguity cluster | medium-ambiguity cluster | non-ambiguity cluster |
|---|-------------------|------------------------|--------------------------|-----------------------|
| Inventory turnover ratio | | 27 | 21 | 15 |
| Average annual machine utilization (%) | | 67 | 67 | 74 |
| Average customer leadtime - from order to delivery (days) | | 25 | 31 | 35 |
| Quantities of manufactured products (%) | One of a kind | 17 | 24 | 22 |
| | Small batch | 31 | 30 | 33 |
| | Large batch | 32 | 25 | 21 |
| | Continuous | 32 | 28 | 27 |
| Standardization/ customization | Engineer-to-order | 29 | 44 | 44 |
| | Standard product | 55 | 43 | 43 |
| | Assembly-to-order | 23 | 19 | 19 |

The obtained three clusters may be compared in terms of the characteristics of analyzed supply chains. It is interesting to observe that the organizations in certain clusters are, to the lesser extent, differentiated in terms of the nature of operations. Strongly discriminating characteristics of the operations performed in analyzed supply chains are shown in Table 3.

It is interesting to observe that supply chains from a high-ambiguity cluster reported the largest, while non-ambiguity cluster indicated the lowest turnover ratio. It may stem from the fact that the level of inventory is lower in a non-ambiguity group as supply chains are more eager to make and deliver products to order. It is also confirmed in the further findings which suggest that supply chains reporting the lowest level of ambiguity manufacture a larger share of ‘one of a kind’ products and products in small batches. They are also more willing to apply engineer-to-order strategy than organizations belonging to a high-ambiguity cluster. As a consequence of manufacturing and delivering more individualized products, an average

customer leadtime is longer in supply chains from a non-ambiguity cluster. Interestingly, the largest annual utilization of technical infrastructure is reported by a non-ambiguity cluster. It is partly due to the fact that operations performed in these supply chains are often customer driven, and thus the utilization rate of machines is slightly larger.

The findings also indicate differences concerning the structure of supply chains. For instance, the largest average number of suppliers and customers is reported by supply chains grouped in a high-ambiguity cluster, whereas the smallest is indicated by a non-ambiguity cluster. Similarly, the highest level of geographical dispersion is mentioned by supply chains in cluster 1 and the lowest level is reported by organizations in group 3. Interestingly, the largest percent of purchases from foreign suppliers (the lowest from domestic providers) is highlighted by supply chains grouped into a high-ambiguity cluster. Completely opposite situation may be observed in supply chains from cluster 3. The similar tendency is observed in the sales to domestic and foreign customers.

The conducted study indicates that the maturity of contemporary supply chains in terms of ambiguity is rather high. The largest share of almost half of the analyzed organizations reported a positive attitude to ensure transparency of the flow of information and knowledge. It may evidence that overcoming ambiguity is an important component of managing contemporary supply chains. In the light of the obtained findings, contemporary supply chains are able to reduce their complexity by decreasing the level of ambiguity *ceteris paribus*. Therefore, it is interesting to analyze if decreasing ambiguity, and thus complexity is always a success factor to operate as a resilient organization.

THE IMPLICATIONS OF AMBIGUITY FOR ORGANIZATIONAL COMPLEXITY OF RESILIENT SUPPLY CHAINS

The study highlights a link between the level of ambiguity and characteristics of analyzed supply chains. The findings suggest that the flow of information and knowledge should be more transparent in order to lower the level of ambiguity, and thus to decrease complexity of the whole supply chain.

However, the study also reveals that although the level of ambiguity is significantly diverse in three clusters, the average performance in each group is rather similar. For instance, the companies in three clusters reported almost the same indices of cost and dynamic of expenditure, including a percentage of sales in the total manufacturing cost, percentage of the total manufacturing cost spend on labor, material or overhead cost. The similar findings may be observed while analyzing the competitive position of the organizations and offered

customer service in each of three clusters. Therefore, the obtained findings bring several practical implications for analyzed supply chains to operate in resilient organizations.

Firstly, the level of ambiguity is not the only factor of complexity. It means that complexity is a multidimensional construct and its elements should be considered jointly. As the obtained findings evidence, organizations grouped into three clusters indicate clearly delineated relationship mostly to the structure of supply chains (e.g. number of suppliers, customers, geographical dispersion, percent of purchases from domestics and foreign suppliers). This is in line with the findings of previous studies. For instance, Craighead *et al.* (2007) when considering resilient supply chains provide the following factors of complexity: supply chain density measured as the quantity and geographical spacing of nodes within a supply chain, interdependence, related both to the number of nodes in a supply chain and to the connections between these nodes, and number of critical nodes in a supply chains. Yates (1978) mentions five characteristics of complexity which may also be considered in resilient supply chains, namely intense interaction, large number of components, non-linearity, asymmetry, non-holonic constraints. Similarly, Steger *et al.* (2007), apart from directly mentioned ambiguity, give the following dimensions which may constitute complexity of resilient supply chains: diversity, interdependence, fast flux.

In the light of the aforementioned, ambiguity should be considered as one of many components of complexity, and thus it does not create complexity individually. On the contrary, ambiguity should be analyzed together with other components in order to ensure the best gap between a holistic complexity of supply chain and its operating environment. It means that ambiguity itself does not determine the whole complexity of supply chains.

Secondly, the level of ambiguity may be different regarding operating environment and specificity of external conditions of supply chains. It means that uncertainty and predictability of events in operating environment of supply chains may be diverse, and thus have a different effect on the level of ambiguity. Resilient supply chain co-evolves with its environment which denotes that organizations are dependent of their surrounding environment, counteract the environment and affect the environment. This is the essence of co-evolution which suggests that resilient supply chains adapt to and influence on the environment. When organizations adapt, their complexity usually grows, on the other hand, when the organizations influence on their environment, they usually make selection process and their structure simplifies. Therefore, different external conditions of operating environment of resilient supply chains may determine the level of ambiguity, and thus the whole complexity.

Thirdly, in case of supply chains operating in certain industries, the level of ambiguity may be purposefully increased in order to raise a total complexity *ceteris paribus* and make a supply chain more vulnerable to external conditions. This situation may take place, when the gap between a total complexity of a given supply chain and its operating environment is growing up. This may put an organization at risk of losing a real contact with its environment. Therefore, increasing complexity is needed to maintain appropriate size of the gap between a total complexity of a given supply chain and its operating environment. This will make supply chains more adaptable and reactive to the uncertain events. Falasca *et al.* (2008) maintain that although a high degree of supply chain complexity makes supply chains more affected by a hazard (i.e. more connections imply more possible disruptions), a higher complexity level also implies more redundancy and, consequently, the potential for higher resilience.

In the light of the aforementioned, if managers of contemporary supply chains, which now operate in more stable conditions, consider to act as a resilient supply chain in future, they have to understand prerequisites of its complexity. The concept of resilient supply chains assumes a different operating mechanism which requires a total redefinition of current pattern of supply chains. Consequently, uncomplicated and obvious rules applicable in a more traditional organizations are not valid anymore in case of resilient supply chains. As the findings demonstrate, it includes ambiguity which does not necessarily have to be always avoided and diminished. Sometimes, diverse level of ambiguity reported by different supply chains operating in certain industries brings similar efficiency, profitability, market strength and perspectives of achieving or sustaining a competitive advantage. Therefore, the level of ambiguity, though it is often high, is maintained in order to keep a certain gap between supply chain complexity and complexity of operating environment. Consequently, it is not always desirable to absolutely, immediately and under all circumstances decrease the level of ambiguity, as it may significantly reduce complexity of supply chain, lessen its agility, mobility and organizational responsiveness.

On the other hand, one should be aware that complexity cannot be permanently controlled by the level of ambiguity. There are other factors which may be used effectively to shape appropriate organizational complexity. Consequently, the level of ambiguity may be used on a short term basis, however it cannot substitute other factors of complexity. In a longer perspective, appropriate gap between complexity of a supply chain and its operating environment should be maintained with the use of diversity (e.g. including more and different links in supply chain structure), interdependence or supply chain dynamics.

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DEVELOPING AND DELIVERING A STUDY ABROAD CLASS: MEETING THE NEEDS OF ALL STAKEHOLDERS

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ABSTRACT

This paper describes the year long process of creation and delivery of a study abroad class. We trace the process from initial inception to final delivery. Although all stakeholders at the university were on board to strengthen the University's study abroad program, it was far from a seamless process to get the class approved, get students enrolled, and finally deliver the class. This paper describes the process, hurdles, and final delivery of a class at our University. We conclude with some lessons learned to help others planning a similar endeavor.

INTRODUCTION

Our university is transitioning from a regional institution, primarily serving one region of a state, to a global institution, including recruitment of students from overseas, as well as throughout the United States. One important metric of this transition is the presence of study abroad opportunities. On paper, our institution is trying to highlight short-term faculty led programs, that is, programs which are hosted by current faculty, as a way to foster greater global awareness and engagement for students.

Research has shown that students who participate in short-term study abroad programs derive benefits beyond the typical classroom experience. Experiential learning enhances students' understanding when it is aligned with students' interests [3][6]. Short-term study abroad provides global learning experiences for students with limited time/money in a focused and intensive manner [7]. Study abroad experiences can help prepare students for functioning in a world that often requires an understanding of operating in a global society [1][5].

Developing a successful study abroad experience can be a challenging experience [7]. The need to develop detailed plans and committed faculty are critical to the success of the program. Pre and post-departure programs can assist with developing realistic expectations for both faculty and student [4].

In addition, faculty learning can result in a greater understanding of student learning and needs, along with a stronger faculty-student relationship, individually, as well as a group [8]. In Instructor-Led Topic/Subject Focused programs, student learning takes place on many levels, including epistemic and philosophical learning, which fosters transformative learning experiences [2]. The everyday experience of living in a foreign country, even for a short time, and meeting the challenges that arise contributes to student problem solving skills and awareness of other cultures [5].

One of the authors has traveled extensively in Costa Rica. Costa Rica is a relatively safe country with an extensive network of already formatted programs. He also had contacts in the country to help arrange a successful program. The second author had led a study abroad experience in the recent past, and was eager to explore content material delivery in a different format, based on her research and homeschooling experience. The process we went through is highlighted in the following section.

PROCESS OF PROGRAM FORMULATION

About twelve months in advance (June of the previous year), two instructors discussed the possibility of offering a Comparative Management class. There was agreement from the beginning to include two faculty members, as both instructors felt it was too much for one faculty member in case there were issues with the group, either health or safety or other issues. [This, by the way, is the model which the institution as a whole has embraced.] Our first step was to develop a tentative syllabus with site visits to local companies and a side trip to Monteverde. This was made easier since one instructor had a contact, a former student who wished to reconnect with his alma mater. Most of the seven company site visits occurred within 30 minutes of San Jose, and included Boston Scientific, Vitek, and Hewlett Packard, as well as some local companies, Dos Pinos and PXSGlobal.

An initial proposal was drafted. The proposal was created to have maximum time to be involved with the onsite experience. We discussed in detail what were considered academic components. The class had to have the same “contact hours” as a traditional class would have had. We included some cultural visits and movement time [bus time] as being useful as contact time. Don’t spend too much time on the particulars at this point, as adjustments are bound to need to be made.

Once the initial proposal was developed, we obtained preliminary signoffs from the department chair and college dean. Since the academic portion of the program was administered through continuing studies, we needed to get their buy in. There was some back and forth here in identifying which aspects of the class were considered academic in nature, but for the most part, they were quite agreeable to our plans, and acknowledged that we best knew how to meet the academic needs of the students.

Once we had the blessing of these administrators, we started working with the study abroad office. This department had to be consulted to obtain the appropriate program costs. At this point, after pursuing the logistics of lodging and transportation in country on our own, and finding this somewhat difficult to do from afar, it was suggested by the Study Abroad office that we initiate contact with two different study abroad organizations with experience in Costa Rica. In our case, two vendors were considered, a regional institution in Costa Rica, and a third party which organized tours on a regular basis.

In waiting to choose a vendor, our time line slipped considerably. The first vendor (the school) reported a reasonable cost, but adjusted our itinerary a lot, trying to implement a more university campus based program. We resubmitted an itinerary, which met some of their needs (ie, visiting their campus, and their satellite campus), but incorporated significant portions of our original itinerary. In addition, they were unable to incorporate our local contact that was going to identify our plant tours. What originally seemed like a promising contact, degenerated quickly, as they questioned the validity of our own alumnus contact. In addition, our main contact at the vendor, got sick, and they did not have a replacement, so there was a 3 week delay in them submitting an updated plan.

In the meantime, the study abroad office was playing with the idea of contracting with a known vendor. The advantage here is that the vendor has extensive experience with delivering study abroad programs. Eventually, they came up with a quote based on the suggested schedule presented to them. It was a bit more expensive, but included a program leader to take care of logistical (primarily transportation and lodging) issues, as well as the first line of interaction in case someone in the group got sick. This may have been one of the best decisions we made. It freed us up to concentrate on the course content and site visits, and eliminated the need for us to schedule and plan housing, transportation, and some tours. In addition, the cost for students did not increase appreciably, and provided the University and parents some additional reassurance of safety.

We agreed to this plan, and then needed to set out recruiting of students. Thus, one of the primary points is know when you are willing to compromise. I was unwilling to compromise as to the itinerary, and was willing to walk away from the entire project.

The second time where we had to set limits was when we had a small number of students sign up. Because of a low number of students, we, as instructors, were asked to take reduced pay, or

to only go with one instructor. We declined both offers, and eventually the money was made up by the Study Abroad office as they really wanted the program to run. Again, we were unwilling to compromise on this issue. It helped that both instructors were in agreement on the matter, and sensed that funding would be made available for the program.

Be prepared to have different entities within the institution to be working at cross purposes. Even though we were in the same institution, there were tensions between the different cost centers. To reduce costs to the students, we asked the Dean for scholarship money. Tuition funds were financed by Continuing Education. However, they had their own formula for payment. They could have still made money (just a smaller percentage) with fewer students, but were unwilling to do so. The Study Abroad office, which had their own budget, first suggested that the rates could be raised on the students, or that we could send one instructor, but eventually picked up the extra costs themselves. This was a very frustrating process, as the instructors' role was greatly expanded beyond simply preparing the class, but got involved in all levels of negotiation including class size, vendor, acceptable costs, and creation of the final schedule. Don't underestimate how much time and energy this process alone takes!

Another area of consideration is the amount of time you must put in as an instructor. Since, study abroad is new at our institution, rules and regulations had not been set in stone. After the program had been accepted to go forward, we had our safety training. Some rules, such as what to do with a sick student, and the information which could be shared [HIPPA rules] made sense, but other restrictions, due to potential legal liability, were quite limiting. As an example, we were told that we could not have a drink with the students, as if they got intoxicated later, we could be seen as enabling this behavior.

We were also told not to mention "dangerous" activities, which included zip lining, a very popular activity in Costa Rica, and actually quite safe. The point here is that there may be severe restrictions placed on your behavior, beyond which you would feel comfortable doing.

In our case, one faculty member was responsible for planning the site visits. It is very helpful if you have a personal contact to help with the site visits. There was some conflict and some miscommunication between myself and the staff organization as to the site visits. It was unclear as to what flexibility there was, and it turned out there was quite a bit of flexibility. In our case, the local contact [former student] identified all of the company visits and helped with arranging the tours. These contacts were absolutely necessary given that a couple had to be rescheduled. It was also helpful for translation purposes, as some of the individuals spoke only Spanish, and translation services were provided.

CONCLUSION

Planning and delivering a study abroad class is much more work than one may first imagine. Beyond working out the logistics on site, developing the curriculum, and delivering the class onsite, multiple bureaucratic hurdles must be overcome. One must be clear of what the administrative hurdles are, and one's responsibilities are onsite. In addition, for many institutions, although staff may be appreciative of the effort which one goes through, it is unlikely to have much of an influence on one's promotion opportunities. If all goes well, it will be a great and satisfying opportunity for both the instructor and the students. However, there are many opportunities for failure, everything from logistical issues (van not arriving on time, more time to clear customs, flights being late, missing visas), health concerns (for many students this may be the first time overseas and mild sickness may seem like a major issue), academic concerns (we had one student who wanted to drop the class midterm), and perception concerns (My spouse came, was she getting a free ride?, The hotel has a bug or two crawling through it). These should not be taken lightly.

Then there are the group dynamics. Are cliques forming? Are students hooking up, and then breaking up? You are on call 24/7, working with many issues beyond classroom delivery. The instructors worked together to address these various concerns, and having two faculty members involved reduced the stress that might have occurred if there was only one faculty member on the trip.

One recommendation we would suggest, for others considering leading a study abroad experience, particularly if this is your first time doing so, is to utilize the services of a company providing study abroad services, such as CIS Abroad. There are a number of study abroad leading organizations available. The CIS program provided a tour leader who was fluent in Spanish, and she was with us from the time we landed in Costa Rica until we left. When a student had to go to a local hospital, the tour leader went with her, and took care of all the testing, insurance, and medication issues. When another student became quite ill, the tour leader arranged for a local doctor to visit the hotel. She kept us informed all along the way of what was happening, and it certainly reduced the stress this might have caused us, and allowed us to continue to deliver the learning experience to the other students. In addition, the tour leader negotiated and handled all the entrance fees and transportation requests while we were on the ground.

Finally, having said all of these precautionary tales, it can be a very rewarding experience for all. Being able to tour several manufacturing facilities helped students move from classroom/textbook learning to real life learning. It was amazing to see students truly understand and see the implementation of cross-functional workplaces, many for the first time—these were real “Aha” moments. As instructors, this was quite heartening, and a real boost to our sense of students developing a better understanding of the connection between classroom learning and

career life. In many respects, this gave us an opportunity to know our students more closely, and have shared a common unique experience with each of them. In addition, we were able to bring back real-life examples to our regular classes, and this resulted in enhanced classroom instruction. Outwardly, it appeared all of our students experienced some degree of growth in business understanding and global learning. It was a great experience, but don't underestimate your time commitment to plan and deliver a study abroad experience!

APPENDIX: SUGGESTIONS FOR SUCCESSFUL STUDY ABROAD PROGRAM

1. Use two faculty members

Things to go wrong. Students get sick. A room is not available. There are "female" issues which come up. Better to have two voices/bodies than one to try and solve the problems. We unintentionally divided activities into student emotional support (co-instructor had homeschooled her children), and logistical support (I had language skills, knew the area, and had the professional contacts from the area.)

2. Be ready to walk away from the program if asked to make concessions beyond which you are willing.

In our case, administration wanted the program to run more than we did. On at least three occasions, we were asked to make concessions (pay, program scheduling, and number of faculty), which we were unwilling to make. Bottom line, your program requirements are likely to evolve, and you should know what you are willing to do, and stick to it, even if means that the program is eventually cancelled.

3. Start early, and develop a flexible project plan.

Flexibility is key. It is likely that at least one set of administrative eyes will likely request changes to the schedule, price, or other aspects of your proposal.

4. Make sure you have in country contacts which are flexible!

It is hard to develop a firm proposal from a distance. People's schedules change. There are airline delays. The transportation provider is late, or you get caught in a traffic jam. Make sure you have contacts in country to help facilitate required changes, and that you keep students informed to lesson disappointments.

5. Identify a timetable which is reasonable, maximum of 14 days

Our program lasted 12 days. Two weeks in 24/7 contact with students, even with good relationships, is a lot. Many students/staff cannot get away from work more than a couple of

weeks. Some students were ready to head home after 8 days. Don't overextend yourselves or the program.

6. Be clear of your expectations for yourself and your students

Where does your teaching day begin and end? Are you staying in the same hotel? Can you give advice as to where to go and not to go? Setting general expectations of all those involved beyond the academic piece of your experience is of utmost importance

7. Make sure all of the administrators are tuned in

Keep everyone in the loop at all steps of the development of your project. Don't assume that the different administrative departments talk to each other. Keep a written record of your communications so that those who give tangential approval without thinking in great detail about specifics can be reminded later.

8. Double and triple check the process and identify those who must sign off

As in the previous suggestion, you cannot be too careful in the process to make sure everyone is in agreement at all stages. Don't make an adjustment in the academic portion, or student requirements without letting all effected parties know through writing or electronic communication.

9. Do some of the academic activities before or after to allow for maximum time abroad to be involved in the experience

In our case, we believed that interaction and involvement with the local culture and on site experiences, which could not be replicated at the home institution, were the best use of students' time while overseas. Lecture presentation, background information of the site location before, and time for reflection and papers after the conclusion of the overseas experience worked best, in our minds.

10. Make it clear whether instructor family members are invited

One of the instructor's spouses accompanied him on the study abroad experience. This turned out to be a sensitive issue, as perceptions of students were important. This was ironed out before departure, but needed to be discussed with school administrators, specifically the Study Abroad office, in our case.

11. Clearly state what your expectations are to be as the instructor. Are you responsible beyond class time?

If you are the instructor, it very well may be that you are decision maker in many issues beyond the classroom, and you must be prepared to make these decisions. When is it appropriate to see a doctor? How much encouragement should you give a student to stay if they decide to leave

early? [In our case, what if a student wants to “drop” the academic component (ie, drop the class), but stay for the cross-cultural experience? We were given guidelines to answer these questions, but had to make decisions or recommendations as they came up. This, by the way, was another reason to have two instructors, who could then discuss pros/cons before a final decision was made.

12. Carefully identify the marketing plan and how much you are willing to get involved in marketing.

The best planned class will not run, if you do not get enough students. This can be very frustrating if you invest a lot of time up front to develop the class and overseas arrangements. When to start marketing? Do you need final approval of the Provost? What is the costing structure for various levels of students? What expenses are covered? What will your pay be? In our case, each of our airfares were covered, but we only received a 50% living stipend since two teachers were co-teaching, as well as 50% of the teaching stipend. Our situation was complicated by the fact that some students were at the graduate level (paying significantly more) than the undergraduates, but it was unclear what the faculty stipend would be. Bottom line, you are not doing this to become rich.

13. Limit the group size to 12 or under. Prepare your plan for choosing of students.

You should have a process of choosing of your students. Is there a minimum GPA? Year (sophomore, junior, senior, graduate student?) What is the application process deadline and how firm is it? (In our case, we ended up extending the deadline for a deposit twice, since undergrads make decisions at the last minute, and in some cases had gotten the buy-in from their parents or appropriate financial aid information together.) Also, although twelve may sound like a manageable size, even a small class size, I believe this is the maximum number of students to go abroad with. Each additional student adds to the complexity of the group dynamics, more health/home sickness issues, eating restrictions, late departures, etc. We had eight students, and it was still a full load.

14. Prepare your schedule so that there are no major gaps where students could potentially leave the area without letting staff know.

Students are adults, but still students. Other programs, which took the weekend off, had students going off to distant cities without consultation with faculty. In some cases, this caused quite a concern, as none knew where they were. By having required activities planned for the weekend, you will greatly reduce this possibility. Our suggestion would be to have at least one planned required activity each day may be a tourist activity, but a planned activity.

15. Strongly consider using an outside study abroad organization to reduce the in-country logistics problems that could arise.

This turned out to be one of the better decisions we made, as it freed us from the daily dilemma of transportation, medical, and organizational tasks necessary to assure a smooth process. The added benefit of having someone who spoke fluent Spanish and was able to communicate well with the drivers and Costa Ricans meant ideas could be communicated quickly and thoroughly. Our tour leader was with us at all times, and took care of addressing students' needs for food, medicine, and bathrooms, among other issues that cropped up. The three of us, faculty members and tour leader, were able to work as a team and collaborate when necessary. The tour leader had led other student tours, and was extremely knowledgeable of activities of interest, places to eat, and sites to be seen. It allowed us to relax and concentrate on the academic aspect of the trip, and interact with the students on levels that were comfortable for us.

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Using Games, Simulations, Exercises and Experiments for Millennial Students of Agricultural Economics

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Abstract: Successfully using games, simulations, exercises and experiments in teaching undergraduate economics, marketing and management classes to today's millennial students requires a bit of magic by including entertainment, business savvy, and some luck. Inclusion of these activities is to complement the lecture and textbook presentations, not replace, as well as to encourage students to make decisions and interact so as to increase interest and decrease skepticism about economic theory. An 'Ah? Ha!' teachable moment is no longer achieved one student at a time, but in mass or in groups, requiring physical participation to find solutions that can't be done using smart phones, computers, or social media at one's desk. The instructor should create a competition for learning using team building exercises to reach consensus ('we-we-we') decisions rather than individual ('me-me-me') decisions. The teacher must establish a teachable moment, an objective or expected learning outcome for each game, simulation, or exercise, and rewards (other than grades) are enumerated prior to the event. Emphasis should be on the 'why' story (not just facts), creating an emotional connection that leads to discovery. Example outcomes for various activities include trading decisions, market demand and demand elasticities, efficient allocations, or diminishing marginal returns.

Background and Literature Review

"If you bet on a horse, that's gambling. If you bet you can make three spades in poker, that's entertainment. If you bet cotton will go up three points, that's business. See the difference?" is a quote attributed to William F. Sherrod on the topic of succeeding in a competitive world, which today encompasses the college classroom as well as the global economy.

The use of games, simulations, exercises and experiments in classroom instruction is not a new concept or learning pedagogy (Heineke and Meile, 1995). There is, however, a newfound reason for including these activities in the teaching environment – the current millennial students respond more favorably to active, competitive, and social instruction of agricultural economics, rather than the standard lectures. Economics is a social science with a theoretic foundation, and has not been praised as an experimental science. As economics has become more technical in forecasting, strategies, and reactions, the use of games, simulations, exercises and experiments provides an important connection between the theories and the key features or concepts being studied (Holt, 1999). Laboratory experiments, ala voting and game theory and trading auctions, have long been conducted as means of proving various economic hypotheses – dating back to the first Nobel Prize sixty years ago.

Game theory is often introduced into undergraduate economics courses, including agricultural economics, using the prisoner’s dilemma paradigm. The prisoner’s dilemma illustrates the conflict between social incentives to cooperate and private incentives to defect, and can stimulate discussion on the business management and economics topics of quality standards, trade barriers, and price competition, among other topics suitable for courses in managerial economics, agribusiness economics, environmental economics, and policy economics. Nonetheless, today’s millennial students seek learning stimulation from other forms of games and activities, such as shuttling tennis balls to learn diminishing marginal returns, building paper airplanes to gain an appreciation for designing and producing and marketing to meet consumer needs, competing for food items (Snickers and Payday candy bars or Coke and Pepsi colas) to learn market demand and demand elasticities and trading decisions, creating menus to see an auction market in action, flipping coins to simulate door-to-door selling, or understanding the payoff of the prisoner’s dilemma using a deck of playing cards.

Goals and Objectives

The goals and objectives for the session are two-fold:

- Gain an appreciation of how to engage the millennial undergraduate economics student and to understand how they learn, especially for those students who may never take another economics course and find no current enjoyment nor need in learning economic theory, concepts, principles or applications.

- Develop a tool box of simple, not time-consuming, yet participative activities to try in their classrooms, including defining the teachable moment or objective or expected learning outcomes for each activity, creating the competitive environment for learning, and establishing rubric or reward mechanisms, as well as actually doing the activity (as time permits).

Descriptions of the Games, Simulations, Exercises and Experiments Used in the Classroom

A simulation is a decision-making tool that requires the development of a model of a process and testing the performance of the model under various conditions; simulation does not find a solution to a problem, however. Using simulation, the decision-maker can take a ‘what-if?’ approach to understanding a problem. In a selling or sales course, for instance, a door-to-door simulation using groups of five students is plausible for the following setup: The economy is bad! You are deciding whether or not to take a part-time job selling XYZ parts door to door, and historical sales information (probability percentages) is available with outcomes. Four coins are needed to complete the simulation representing the random variable of someone answering the door, whether a male or female answers the door, and the success of the sales call. A simulation worksheet is provided to document the number of coins flipped and the number of parts sold during one night’s work of making twenty calls. How did each group do, and what kept them from doing better? Obviously, no sales if no one was at home.

Classroom economic experiments typically involve monetary payoff, suggesting that significant financial incentives are inherent. If money is at stake, the college’s administration must be accepting and on board with the concept, so that the interpretation to students and other stakeholders is not one of gambling. Small monetary incentives may be useful, if only because they reduce the noise in the decisions, but are not necessary. The use of extra credit or bonus points as incentives is much more controversial since fairness becomes a constraint that may conflict with the teaching purpose, adding stress and conflicting with the key economic ideas, like mutual benefits from trade. Several experiments are available, either online or from the author.

An interactive exercise that teaches the concept of marginal returns to students requires two buckets and a number of tennis balls. Students are told they are part of the inputs required to generate a factory’s short run production function. For each assembly line, one student is the timekeeper and a second is the output recorder while the other students become workers on the production line. The buckets are placed about 20 feet apart in the

classroom, and the first worker picks up one tennis ball at a time and runs to the other bucket, placing the ball in the bucket, and then returns to the first bucket to collect the next ball. The goal is to transfer as many tennis balls as possible between buckets in thirty seconds. What would make this line more efficient? More workers! So a second worker is added to the process. The balls must be handed (not tossed) between the workers, and determine how many balls can be transferred in 30 seconds. Add a third worker, then a fourth, etc. At the end of each 30 seconds period, the balls are counted and returned to the first bucket. Continue the 30-second runs until negative returns can be demonstrated (fewer balls are transferred in 30 seconds because too much time lost with many workers in the line – inefficiency). Graphing the data is also of help to the students to understand the concepts, especially as to when adding workers – when marginal return starts to decrease or when it becomes negative. In teaching production functions, an understanding to total product, average product, and marginal product (and their relationships) can be achieved with the same exercise.

Several versions of the classroom game, a prisoner's dilemma, provide a basis for understanding game theory. The prisoner's dilemma illustrates the conflict between social incentives to cooperate and private incentives to defect. This game efficiently involves a large number of students, and can be played either with a basic deck of playing cards (red versus black) or cans of mini-colas (Coke versus Pepsi, or The Real Thing versus The Next Generation). The objective is to win as much money as possible. The extent of cooperation is affected by the payoff incentives and by the nature of repeated interaction, even in finite-horizon situations where standard theory predicts uniform defection. For the Coke-Pepsi version, in the first round of ten rounds, a student are partnered (teamed) with another student and they confer as to whether they want to choose a Coke or a Pepsi before proceeding to round 2 where they become part of a group of two teams. Upon conferring with the partner and the group, either a Coke or a Pepsi can is displayed upon the signal from the instructor, and a payoff occurs: 4 Cokes = all lose \$1,000; 3 Cokes and 1 Pepsi – each Coke wins \$1,000 and the Pepsi loses \$3,000; 1 Coke and 3 Pepsis = Coke wins \$3,000 and 3 Pepsis each lose \$1,000; 4 Pepsis – all win \$1,000 each; and 2 Pepsis and 2 Cokes = Pepsis each win \$2,000 and each Coke loses \$2,000. Rounds alternate between conferring only with the partner and conferring with the partner and another group, until 10 rounds are complete. The winnings and losses can be exacerbated by multiplying the winnings and losses by 3 in round 5, by 5 in round 7, and 10 in round 10. Students are rewarded for participating by having their choice of a Coke or a Pepsi at the end.

Discussion and Implications

What is more important as a take-home message for the students: the quantitative calculation or proof of a theory, or the understanding of the implications of the realities, the why's and the what-if's of the theory or concept? For today's millennial students, the latter seems to be more significant. These activities allow for this learning by doing. Several positive results occur from this change in teaching: students seem to remember concepts reinforced with an active learning activity, and it provides a nice change of pace to the normal classroom from lectures.

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Measuring the Life Cycle Assessment and Economic Carbon Footprint of a Golf Course

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Abstract: In Georgia, nearly 500 recreational golf courses utilize turf grass for fairways, greens, tee boxes, and rough, plus nursery plants (annuals and perennials) for aesthetic landscaping and erosion control. Resource intense recreational activities, such as golf, impact the environment and greenhouse gas emissions (primarily CO₂) from its operations and maintenance strategies, facility and equipment utilization, and pedestrian traffic densities. To achieve carbon neutrality and sustainability, the life cycle assessment (LCA) of a golf course must be evaluated and revisions to the current operations and maintenance strategies must be developed. So how is a golf course carbon footprint measured and how is a life cycle assessment developed. The carbon contribution and the carbon sequestration in carbon dioxide equivalents are determined upon completing an inventory analysis, an impact analysis, and an improvement analysis. These methodologies are employed for six collaborating Georgia golf courses.

Background and Literature Review:

The definition of sustainability goes beyond the concern of just 'going green' (environmental impact), or being environmentally friendly, organic, natural, reducing greenhouse gas emissions, minimizing global warming, reducing the carbon dioxide equivalents, and so forth. There are three components to sustainability: economic (profitability) effects, societal or community effects, and environmental effects. The challenges to developing a business investment case for sustainability are two-fold: forecasting and calculating the benefits and costs long term and planning well beyond the one-to-five year time horizon typical of most investment frameworks; and gauging the system-wide effects (peripheral businesses and industries, including neighboring activities) of sustainability investments in a life cycle assessment.

What is a life cycle assessment? The US Environmental Protection Agency defines a LCA as "...a tool to evaluate the environmental consequences of a product or activity holistically across its entire life," from conception

and development through to maturity and demise. A life cycle assessment is system-oriented because it attempts to integrate environmental requirements into each stage of the golf course development and operations/maintenance process, including landscaping, so that total impacts caused by the entire system can be reduced. A life cycle assessment normally follows three distinct steps:

- An inventory analysis that identifies materials and energy resources and their flow patterns;
- An impact analysis of qualitative and quantitative assessments of the consequences to the environment; and
- An improvement analysis that contemplates actions that can be taken to improve upon current conditions.

The lack of relevant and verifiable and quantifiable inventory data from all participants is the biggest hindrance to completing a life cycle assessment for a golf course. After all, the participant list includes golf course designers and developers, heavy machinery equipment manufacturers and operators, sod farms and production nurseries, turf maintenance equipment manufacturers/operators and pesticide product manufacturers and application equipment manufacturers/operators, plus the employees of the golf course superintendent (Baird, 2011; Valenti, 2010). What's missing is a common understanding of determining value, the multiplier effects, job creation, increases in revenues or lowering of costs, the environmental impacts, the quality of the golfing experience, any improved health (reduced pollution, cleaner water, etc.), the book value and costs of operating inventory items such as equipment, and the efficiency factors of equipment and labor in reducing carbon dioxide emissions (Selhorst, 2011).

Numerous assessment factors indicators are integral for calculations of a golf course life cycle assessment . A glimpse of the assessment indicators and factors for the establishment and installation of golf course is shown in Figure 1.

If the on-course operations of a golf course, including the indoor efficiency issues of the clubhouse, concessions, offices, changing rooms and bathrooms, pro shop, maintenance compound, hvac units, roof and wall installation, windows and window treatments, plumbing and electrical connections, are evaluated, vast data is necessary to calculate the life cycle assessment (Maestas et al, 2012).

Objectives:

The goals and objectives for this research are two-fold:

- Discuss the three distinct steps in conducting a life cycle assessment, and apply the inventory analysis and impact analysis to a golf course, and
- Calculate the annual net carbon (carbon contribution [metric tons of carbon dioxide equivalents per year] minus the carbon sequestered), and provide recommendations for reaching carbon neutrality.

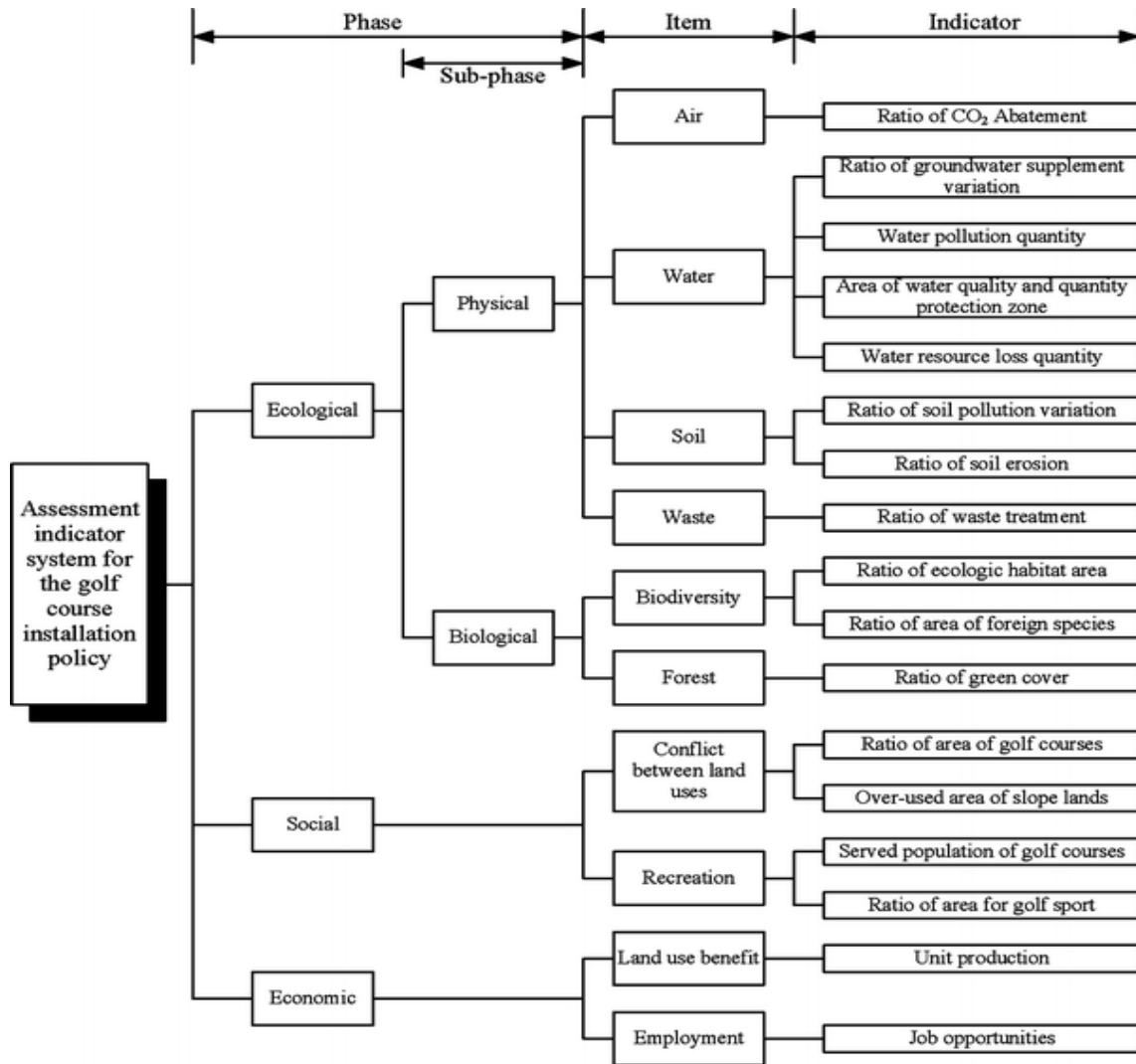


Figure 1. The assessment indicators and factors for the establishment and installation of golf course (Chen et al, 2009)

Methodology

The methodologies employed for calculating the carbon footprint and life cycle assessment of six collaborating Georgia golf courses were nonlinear regression analysis for determining a price-based carbon footprint, an energy-based carbon footprint, carbon sequestration by forest and vegetation type, carbon sequestration of the soil profile, and carbon sequestration of golf course turf grasses, all from a limited sample size of six. The six course in the study represented two private, two public municipal, and two state-run (public) courses in three distinct geographical areas (two in Atlanta metro area, two in the interior Piedmont, and two coastal) with varying management and operational practices, and a variety of resources (labor, money, equipment, management skills and strategies, etc.). Carbon emission totals were calculated by event, resource use, turf quality, and time, and then converted into total carbon dioxide equivalents, CO₂e.

Results and Discussion:

Selected findings from the six golf courses are presented below:

| Course | Carbon Contribution | Carbon Sequestered | Net Annual Carbon |
|---------|---------------------------------|-------------------------------|---------------------------------|
| 1 | 1,337 MT CO ₂ e/year | 157 MT CO ₂ e/year | 1,181 MT CO ₂ e/year |
| 2 | 416 | 130 | 286 |
| 3 | 465 | 113 | 353 |
| 4 | 739 | 133 | 606 |
| 5 | 1,017 | 141 | 876 |
| 6 | 848 | 125 | 723 |
| Average | 681 MT CO ₂ e/year | 133 MT CO ₂ e/year | 548 MT CO ₂ e/year |

The data shows that golf courses could be managed in a way that would approach carbon neutrality. For instance, courses #2 and #3 had net annual carbon emission rates that could be offset with relatively small management adjustments, such as switching from petroleum diesel to local biodiesel, or reducing the amount of

municipal water used for watering waste areas to reduce evapo-transpiration rates, and/or by implementing better fertilization and pest management regimes and using more annual and perennial vegetative plants, without knowingly reducing turf quality.

Due to the small number of participants, this study does not offer sufficient data to be representative of the region or all golf courses. The outcomes cited offer a conservative assessment of carbon emissions from operations and maintenance resource use and the imbedded CO₂ sequestration potential to offset these emissions for these particular courses, but does suggest golf course operations and maintenance, if optimized, could approach carbon neutrality.

Few life cycle and carbon cycle assessments of recreational activities have been conducted. This may be due to the limited economic incentive to make recreational venues such as golf courses more efficient, or it could be a social dynamic that does not view these activities as having negative environmental impact or potential. Regardless, the good news for the environmental horticulture sector is that environmental horticulture vegetation is treated as a carbon sink (reduced the greenhouse gas emissions), while other inventor items are sources of greenhouse gas emissions and carbon contributions.

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PERCEPTIONS OF CRISIS AND DISASTER PREPAREDNESS, SAFETY, AND FEAR AMONG UNIVERSITY FACULTY AND STAFF: AN EXPLORATORY STUDY

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ABSTRACT

The results of this survey of a small school of business faculty and staff indicate that respondents are concerned that a disaster or crisis is a likely occurrence. The potential for severe consequences including injury or death is acknowledged. Campus training programs highlight the potential for a likely emergency while not providing certainty regarding safety and protection in the event of an emergency. Consequently, to some extent training programs are viewed as helpful but incomplete. Future topics and directions are explored.

INTRODUCTION

While crisis and disaster preparedness planning has long been discussed in the emergency management literature, the catastrophic events of 9/11, among numerous others, catapulted this area of research into many diverse disciplines beyond its original scope. The mid 2000s saw a proliferation of new books and journal articles that addressed a multitude of aspects related to organizational planning for responses to cope with potentially devastating events. The ability of modern media technology ensures that the public not only learns of the event, but the graphic visual recordings are now part of today's reality. In response, practitioners and academics alike have answered the call for better and more advanced crisis and disaster preparedness planning in an effort to improve responses when a critical event occurs. This exploratory research investigates perceived crisis and disaster preparedness and resulting feelings of safety and/or fear of faculty and staff at one school of business.

BACKGROUND AND LITERATURE REVIEW

Crisis and Disaster Preparedness

Efforts to point out that the intellectual foundations of crisis and disaster management remain underdeveloped include Pearson and Clair [10], Pearson, Roux-Dufort, and Clair [11] and Barton [1]. Fowler, Kling, and Larson indicate that employees may not feel adequately prepared to cope with a disaster or crisis in their work environment [3]. While crisis events have been described as low-probability, high consequence events attention has been drawn to the consequences of a new reality. Examples have been primarily industry specific. Ritchie, Bentley, Koruth and Wang examined proactive crisis planning in the accommodation industry [14]. Their findings indicate support for organizational type and size having an impact on perceived level of crisis preparedness. Jin also examined the interplay of organizational type and size in a sample of public relations practitioners in the United States [4]. Results were mixed, but organization type was found to be effective when it interplayed with practitioner role or organization size. Patten, Thomas, and Wada surveyed college student and faculty opinions on their attitudes towards private citizens carrying concealed guns on campus [9]. Their findings indicate over 70% of respondents oppose the option of carrying concealed guns on campus, indicating that the idea of more guns on campus makes students and faculty feel less safe. In a related opinion, Nykodym, Patrick, and Mendoza argue that more firearms are being purchased by members of the community while layoffs of police impact college and university communities who rely on them for security challenges [8].

Safety and Fear

Theory implies that employees may experience strong negative cognitions and emotions, such as fear, confusion, and anxiety, when contemplating the possibility of a crisis or disaster [2]. In response, these researchers suggest that methods to counteract these responses need to be implemented in the planning stage. Additionally, Clair and Waddock report evidence that the psychological and physical safety of employees who could be involved in a crisis needs to be demonstrated [2]. Attention to these human concerns might increase the probability that employees would be able to respond appropriately to a crisis or disaster event. Limited training in how to respond to a crisis might not be adequate. These researchers argue that employees may experience strong negative cognitions such as fear, confusion, and/or anxiety when faced with the possibility of a crisis and methods must be implemented in advance of employees actually encountering a crisis.

Other researchers recognize the psychological response to safety/fear cognitions with respect to implementing crisis and disaster preparedness. While the sample population consisted of students, instead of employees, the constructs of safety and fear may be analogous to university faculty and staff populations. Perumean-Chaney and Sutton examine the relationship between the visible presence of security measures and the resulting impact on student perceptions of safety or fear of school crime [12]. The underlying logic of their research is, the more visible the security measures in a school the conclusion is that the school is unsafe—otherwise why would we need these security measures? Their research indicates that the use of metal detectors and at least two other physical security measures are associated with a significant decrease in students' feeling of being safe while at school.

Another study using student focus groups examines student perceptions of disaster risk, fear, preparedness, and reflections on Union University—which was harshly struck by a tornado [5].

The student focus groups' comments were gathered before the students viewed a CNN video depicting the tornado's impact. The pre-video comments were decidedly different from the post video comments. Perhaps one of the most striking student comments came from a student who gave campus tours to prospective students and their parents. The student reported that parents frequently asked what the campus had in place to prevent an incident like Virginia Tech. The student commented that academic buildings are "so vulnerable anybody could walk in almost any hour of the day, even late into the night. Anybody can walk into any classroom in this building right now" [5, p. 139]. This study also controlled for gender differences. For example, initially (pre-video) females were more likely to express fear than their male counterparts. However, after viewing the CNN video of the tornado-impacted university campus, males retracted some of their initial brave statements of not being afraid or taking proactive planning seriously. Others have commented on the challenges of open-access campuses as well. "A college campus is a quintessential example of this security challenge" [6].

HYPOTHESES

Previous research conducted by Fowler, Kling, and Larson indicated that employees do not feel prepared for coping with a major crisis or disaster [3]. However, because their results were reported in aggregate, at the organizational level, it is not possible to ascertain in what areas employees might feel more prepared than in others (e.g., evacuation plans, communication, workplace security, possibility of a crisis occurring at their workplace, and so on.) It is possible employees might feel prepared for evacuation but feel unsafe with respect to workplace security. It is our intention to delve deeper into these areas of workplace security.

On our campus, safety and security is administered by our county sheriff's department. The sheriff's department maintains a full-time staff on campus 24/7 and their patrol cars are seen regularly patrolling campus. Our campus has emergency call stations located across campus for a caller to be able to reach the sheriff's department 24 hours a day. Classrooms have posters near each door indicating instructions of what to do in the event of an emergency, along with an evacuation map.

This semester the sheriff's department provided voluntary training to faculty and staff on what to do in the event of a crisis or disaster on campus. The officers described the need to be aware of our surroundings and alert to any persons who appear suspicious. As part of this training, faculty and staff were shown a video on what to do if an active shooter was present on campus and faculty and staff discussion and questions followed. In line with Pearson and Clair's conceptual foundation, our research is designed to test the construct that pre-event crisis and disaster planning should result in higher levels of perceived preparedness [10]. Of note, some of the topics addressed by our survey of faculty and staff were not addressed in the training, consequently we might conclude that there would be no discernible differences between those attending the training and those who did not attend the training. However, the research literature is just emerging and it is also possible that safety training may provide halo effects that impact behaviors, beliefs and perceptions in areas not directly included as part of the training.

Our hypotheses are based on the fragmented literature available. The topics not addressed in the training will be highlighted in the results and analysis section. Therefore the following hypotheses are offered:

Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be

- *Hypothesis Ia: more informed about exits, evacuation plans, location of fire extinguishers and so on.*
- *Hypothesis Ib: no more informed about contingency plans for jobs, compensation, and benefits. (Not Addressed in the Training)*
- *Hypothesis Ic: no more informed about communication plans following a crisis or disaster. (Not Addressed in the Training)*
- *Hypothesis Id: more confident that the workplace is secure.*
- *Hypothesis Ie: more likely to consider a crisis or disaster a real possibility.*
- *Hypothesis If: more likely to conclude that there would be negative consequences for the campus, the students, and our stakeholders if a crisis/disaster were to occur.*
- *Hypothesis Ig: more aware of security enhancements.*
- *Hypothesis Ih: more likely to volunteer for or accept obligations to make the campus more secure.*

Having taken the county sheriff's training, faculty and staff will feel

- *Hypothesis IIa: safer at work.*
- *Hypothesis IIb: more competent to respond to a crisis or disaster on campus.*

METHODS

To test the hypotheses listed above a faculty/staff survey instrument was adapted from the survey used by Fowler, et al., [3]. The adaptations of the survey included wording changes to situate the questions in the university setting, along with additional changes to make the survey applicable to the job and duties of university faculty and staff. The survey addressed a number of themes as noted in the hypotheses previously stated. For most of the hypotheses multiple items addressed various facets of the construct examined.

The survey was administered using an electronic online software vendor with individual survey links sent to each individual. Two follow-up email prompts were sent to encourage participation. Survey links were sent to 35 individuals and 29 employees participated in the survey for a 83% response rate. The population of potential respondents included all faculty and staff (not including student staff) of a medium-sized school of business in a small regional public institution in the US.

The survey included three demographic questions on gender, position and age followed by thirty three items related to individual perceptions and attitudes regarding the potential for a campus crisis or disaster, campus-wide preparation for a crisis or disaster and individual level preparation for a crisis or disaster. At the end of the survey a few questions were answered only by the respondents who were present for the safety training. These items evaluated perceptions of the effectiveness and impacts of the training.

All of the research items were measured using response categories, Strongly Disagree, Disagree, Agree, Strongly Disagree. These categories were not converted to numerical values, rather hypotheses testing was conducted using the Fisher Exact Test of difference of proportions [13]. Since the expected cell values were small due to the small population the strongly agree and agree cells were collapsed into a single agree outcome, while the strongly disagree and the disagree outcomes were combined into a single disagree cell.

RESULTS AND ANALYSIS

Demographic results are summarized in the table below. Since a large fraction of the population responded to the survey the sample demographics closely resemble the population.

| Table 1: Demographics and Training Results | | |
|--|-----------|----------|
| Gender | Responses | % of Tot |
| Male | 19 | 65.52% |
| Female | 10 | 34.48% |
| Position | Responses | % of Tot |
| Faculty | 24 | 82.76% |
| Other | 5 | 17.24% |
| Age | Responses | % of Tot |
| <=29 | 1 | 3.45% |
| 30-39 | 3 | 10.34% |
| 40-49 | 5 | 17.24% |
| 50-59 | 12 | 41.38% |
| >=60 | 8 | 27.59% |
| Trained | Responses | % of Tot |
| Yes | 18 | 62.07% |
| No | 11 | 37.93% |

The research results and discussion will be presented in connection with the stated hypotheses. The item responses will be presented in connection with the relevant hypotheses tests. Regarding the alternative hypotheses,

- p_t = proportion of the trained respondents who agree
- p_u = proportion of the untrained respondents who agree
- $Pr(\text{Fisher})$ = the probability of the value of the Fisher Exact Test

The null hypothesis for each item is that the proportion of trained respondents who agree is equal to the proportion of untrained respondents who agree. The alternative hypotheses for each item are presented in the tables that follow.

Hypothesis Ia: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be more informed about exits, evacuation plans, location of fire extinguishers and so on.

| Table 2: Results and Hypothesis Tests for Hypothesis H1a | | | | |
|---|--------|--------|----------------|------------|
| Questions testing this hypothesis | p_t | p_u | Alt Hypothesis | Pr(Fisher) |
| Q4. I am very familiar with the building evacuation plans. | 0.6667 | 0.3636 | $p_t > p_u$ | 0.1137 |
| Q7. I know where the main shutoffs are located (e.g. electrical, gas, water). Not Addressed in the Training. | 0.1111 | 0.0909 | $p_t > p_u$ | 0.6839 |
| Q12. In the event of an emergency or disaster, I am familiar with my organization's plan to continue operations from another location. Not Addressed in the Training. | 0.0556 | 0.0000 | $p_t > p_u$ | 0.6207 |
| Q13. All campus employees are required to rehearse portions of our crisis plan. | 0.1111 | 0.1818 | $p_t > p_u$ | 0.49324 |
| Q15. The university should provide each employee with a basic emergency preparedness kit at the organization's expense. Not Addressed in the Training. | 0.4444 | 0.6000 | $p_t > p_u$ | 0.3473 |
| Q21. I know where the nearest fire extinguisher is to my desk/office and classrooms. | 0.3333 | 0.3636 | $p_t > p_u$ | 0.7171 |
| Q23. Most campus employees are familiar with the campus crisis/disaster plan. | 0.2353 | 0.1818 | $p_t > p_u$ | 0.5610 |
| Q30. Campus policies provide for volunteer employees to be trained in basic life support techniques, such as CPR, first aid, etc. at the university's expense. Not Addressed in the Training. | 0.3333 | 0.4545 | $p_t < p_u$ | 0.8496 |
| Q35. I know where the nearest emergency exits are to my desk/office and classrooms. | 0.9411 | 0.9090 | $p_t > p_u$ | 0.8545 |
| Q36. The campus emergency plan has been coordinated with local agencies, such as fire departments, hospitals, police/sheriff departments, etc. Not Addressed in the Training. | 0.8571 | 0.8181 | $p_t > p_u$ | 0.5935 |

Scanning the table above and comparing the proportion of agreement for trained (t) and untrained (u) respondents there appears to be little demonstrable differences in the perceptions of the two groups except in the case of the familiarity with the building evacuation plan. Trained respondents were nearly twice as likely to be aware of the building evacuation plan as compared to the untrained respondents. Of note is that across all respondents there is little familiarity with the campus crisis/disaster plan(s). Only in the cases of familiarity with the building exits and a belief that the campus emergency plan is coordinated with local emergency agencies does a majority of the respondents indicate familiarity with emergency plans/preparations. Based on the Fisher Test there are no significant ($\alpha = .05$) differences in reported perceptions between the trained and untrained groups.

Hypothesis Ib: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be no more informed about contingency plans for jobs, compensation, and benefits.

| Table 3: Results and Hypothesis Tests for Hypothesis H1b | | | | |
|--|--------|--------|----------------|------------|
| Questions testing this hypothesis | p_t | p_u | Alt Hypothesis | Pr(Fisher) |
| Q6. If the university suffered a serious crisis, like those mentioned in the instructions, I might lose my job. Not Addressed in the Training. | 0.2222 | 0.0000 | $p_t \neq p_u$ | 0.2678 |
| Q8. If the university suffered a major crisis, I would still get paid until we couple reopen. Not Addressed in the Training. | 0.7059 | 0.7000 | $p_t \neq p_u$ | 1.0000 |
| Q17. If the university suffered a serious crisis, I would still have my job. Not Addressed in the Training. | 0.8824 | 0.7000 | $p_t \neq p_u$ | 0.3261 |
| Q19. If the university suffered a serious crisis, I would still be covered by the campus employee benefits (e.g. health insurance, etc.) Not Addressed in the Training. | 0.9375 | 0.7778 | $p_t \neq p_u$ | 0.5304 |
| Q29. If the university suffered a crisis/disaster, I would have the data I need to do my job backed up at a remote site. Not Addressed in the Training. | 0.5000 | 0.7273 | $p_t \neq p_u$ | 0.2732 |
| Q31. I am familiar with the university's contingency plans in place so that classes could continue and students would be served, if we suffered a disaster. Not Addressed in the Training. | 0.1176 | 0.0000 | $p_t \neq p_u$ | 0.5053 |

A comparison of the proportion in agreement between the trained and untrained groups indicates no apparent differences between the groups. Since these topics were not addressed in the training it is not surprising that there are no significant differences. These responses suggest that faculty and staff believe that a crisis or disaster would not threaten their contractual relationships with the university including employment, compensation and benefits and that they have little knowledge of the contingency plans in place for the continuation of campus functions and operations in the event of a crisis or disaster.

Hypothesis Ic: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be no more informed about communication plans following a crisis or disaster.

| Table 4: Results and Hypothesis Tests for Hypothesis H1c | | | | |
|--|--------|--------|----------------|------------|
| Questions testing this hypothesis | p_t | p_u | Alt Hypothesis | Pr(Fisher) |
| Q11. If a crisis occurred at the university, I am familiar with the plan for how family members can get information on the status (e.g. safety) of their relatives. Not Addressed in the Training. | 0.2222 | 0.0000 | $p_t \neq p_u$ | 0.7112 |

| | | | | |
|---|--------|--------|----------------|--------|
| Q22. If a crisis and evacuation occurred, I am familiar with our plan on how to communicate with my fellow employees from scattered or emergency locations (such as cell phone numbers, calling trees, websites or email lists). Not Addressed in the Training. | 0.2941 | 0.1818 | $p_t \neq p_u$ | 0.6683 |
| Q26. As part of our emergency plan family members and the press, along with business and community partners, would be able to contact the university for information. Not Addressed in the Training. | 0.6875 | 0.6364 | $p_t \neq p_u$ | 1.0000 |

A comparison of the proportion in agreement between the trained and untrained groups indicates no apparent differences between the groups. Since these topics were not addressed in the training it is not surprising that there are no significant differences. Similar to the results reported for hypothesis Ib faculty and staff report a low level of awareness of the communication plans of the campus during an emergency, but a majority of the respondents report that they believe that the campus does have a plan for communication with the press and other community partners in the event of an emergency.

Hypothesis Id: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be more confident that the workplace is secure.

| Table 5: Results and Hypothesis Tests for Hypothesis HIid | | | | |
|---|--------|--------|----------------|------------|
| Questions testing this hypothesis | p_t | p_u | Alt Hypothesis | Pr(Fisher) |
| Q5. It would be easy for a potentially threatening non-employee/non-student to gain access to my workplace. | 0.9444 | 0.9091 | $p_t < p_u$ | 0.6232 |
| Q9. The security at my workplace is adequate. | 0.3889 | 0.2727 | $p_t > p_u$ | 0.4112 |
| Q27. The campus classroom security is adequate to protect instructors and students while in class. | 0.1111 | 0.1000 | $p_t > p_u$ | 0.7161 |

A comparison of the proportion in agreement between the trained and untrained groups indicates no apparent differences between the groups. Regarding interpretation of these responses and the topics included in the training, these items were central to the training provided by the sheriff's department. It consequently was expected that the training would have had some impact on the perceptions of the individuals attending the training. We hypothesized that the trained faculty and staff would feel safer in the workplace, but this hypothesis was not supported. The faculty and staff reported that they believe an intruder could easily enter the workplace and that security is not adequate to protect instructors and students while in class. These responses were uniform for both trained and untrained respondents.

Hypothesis Ie: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be more likely to consider a crisis or disaster a real possibility.

| Questions testing this hypothesis | p _t | p _u | Alt Hypothesis | Pr(Fisher) |
|--|----------------|----------------|---------------------------------|------------|
| Q14. An active shooter incident at the university is a real possibility. | 0.9444 | 0.9091 | p _t > p _u | 0.8645 |
| Q33. A crisis or disaster at the university is a real possibility. | 0.9375 | 0.9000 | p _t > p _u | 0.8615 |

A comparison of the proportion in agreement between the trained and untrained groups indicates no apparent differences between the groups. Regarding interpretation of these responses and the topics included in the training, these items were central to the training provided by the sheriff's department. It consequently was expected that the training would have had some impact on the perceptions of the individuals attending the training. We hypothesized that the trained faculty and staff would be significantly more aware of the potential for crisis when compared to the untrained group, but the differences in awareness between the two groups was not significant. Consistently, the faculty and staff reported that they believe an active shooter on campus or a campus crisis/disaster is a real possibility. These responses were uniform for both trained and untrained respondents.

Hypothesis If: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be more likely to conclude that there would be negative consequences for the campus, the students, and our stakeholders if a crisis/disaster were to occur.

| Questions testing this hypothesis | p _t | p _u | Alt Hypothesis | Pr(Fisher) |
|--|----------------|----------------|---------------------------------|------------|
| Q16. Our students' options and opportunities would be hurt significantly if the university suffered a crisis. Not Addressed in the Training. | 0.8824 | 1.0000 | p _t > p _u | 0.3598 |
| Q24. Our business and community partners would be hurt significantly if the university suffered a crisis. Not Addressed in the Training. | 0.7647 | 1.0000 | p _t > p _u | 0.1356 |
| Q32. If an organization has not done sufficient crisis planning and preparation, administration and faculty could be held personally liable for any serious injuries or deaths to employees, or students resulting from a crisis or a disaster. Not Addressed in the Training. | 0.3750 | 0.8182 | p _t > p _u | *0.0282 |

* Significant at $\alpha = .05$

The results for hypothesis HIf included significant differences in responses between the trained and untrained groups. Even though not directly addressed in the training we hypothesized that the trained group would be more perceptive and attuned to the potential for harm to the institution associated with a crisis or disaster, but the results did not support our hypothesis.

Rather, the results indicated that the untrained individuals were more likely to agree with statements predicting harm to the institution and its employees.

The significant response regarding personal liability for damages associated with a crisis or disaster can be understood when we consider that the trained individuals may have come away from the training with more awareness of the disaster management team and the campus emergency plans thus reducing the perceived likelihood of personal liability in the event of a disaster.

Hypothesis Ig: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be more aware of security enhancements.

| Table 8: Results and Hypothesis Tests for Hypothesis HIg | | | | |
|--|--------|--------|----------------|------------|
| Questions testing this hypothesis | p_t | p_u | Alt Hypothesis | Pr(Fisher) |
| Q20. Security at the university has been significantly increased since the terrorist attacks on 9/11/2001 and the repeated campus shooting incidents at high schools and universities. | 0.2941 | 0.4546 | $p_t > p_u$ | 0.3205 |

Responses from the trained group suggest that they were not aware that campus security had increased in response to terrorist attacks nationally and campus shooting incidents. The responses from untrained individuals similarly suggested little awareness of campus security enhancements. There was no significant difference in the response of the two groups.

Hypothesis Ih: Compared to individuals who did not take the county sheriff's training, individuals who attended the training would be more likely to volunteer for or accept obligations to make the campus more secure.

| Table 9: Results and Hypothesis Tests for Hypothesis HIh | | | | |
|---|--------|--------|----------------|------------|
| Questions testing this hypothesis | p_t | p_u | Alt Hypothesis | Pr(Fisher) |
| Q10. I would be willing to spend my own money (approximately \$100-\$150) to purchase a basic emergency preparedness kit (flashlight, smoke mask, etc.) to keep at my desk/office. Not Addressed in the Training. | 0.3889 | 0.7273 | $p_t > p_u$ | 0.0821 |
| Q18. I would volunteer to be trained in CPR and basic first aid at the university's expense. Not Addressed in the Training. | 0.8333 | 0.9091 | $p_t > p_u$ | 0.5067 |
| Q25. I would volunteer to be a disaster coordinator or disaster recovery team leader for school. Not Addressed in the Training. | 0.3333 | 0.7000 | $p_t > p_u$ | 0.0706 |

The premise of this hypothesis was that having attended the training an individual would be more likely to take an active role in improving campus preparedness. In reality the opposite

effect was demonstrated by the responses to these items. Untrained respondents were more than twice as likely to indicate a willingness to make personal commitments and/or sacrifices to improve campus emergency preparedness when compared to the respondents who attended the sheriff's training. Two of the items Q10 and Q25 were near significance on the Fisher Test for difference of proportion. Further discussion of this result will be provided in a conclusions section to follow.

The last two hypotheses are associated with questions directed only to the respondents who completed the training. The table presentation of these results, while similar to the previous tables, will use a little different nomenclature as follows.

p_{tA} = proportion of the trained respondents who agree

Hypothesis IIa: Having taken the county sheriff's training, faculty and staff will feel safer at work.

| Questions testing this hypothesis | p_{tA} | Alt Hypothesis | *95% CI, P_{tA} |
|---|----------|-------------------|-------------------|
| Q40. Having attended the emergency training I feel safer in my office. | 0.4375 | $p_{tA} > p_{tD}$ | 0.2310, 0.6682 |
| Q41. Having attended the emergency training I feel safer in our classrooms. | 0.2353 | $p_{tA} > p_{tD}$ | 0.0956, 0.4726 |

*95% confidence interval calculated using Newcombes Method (Newcombe, 1998)

The hypothesis that training would increase the respondents' perception of safety was not supported by these results. Rather the results contradict the safety hypothesis indicating that trained individuals do not feel safer in their offices or the school's classrooms. Trained faculty and staff feelings of anxiety regarding safety in the classroom were significant at $\alpha = .05$. Further discussion regarding psychological impacts of preparedness training will be provided in the conclusions.

Hypothesis IIb: Having taken the county sheriff's training, faculty and staff will feel more competent to respond to a crisis or disaster on campus.

| Questions testing this hypothesis | p_{tA} | Alt Hypothesis | 95% CI, P_{tA} |
|---|----------|-------------------|------------------|
| Q39. Having attended the emergency training I feel better prepared to respond appropriately in a crisis or emergency. | 0.52941 | $p_{tA} > p_{tD}$ | 0.3096, 0.7383 |

The hypothesis that training would increase the respondents' perception of competence in responding to an emergency was not supported by these results. The evidence suggests that trained respondents are equally divided regarding their level of preparedness for responding to a crisis.

DISCUSSION AND CONCLUSIONS

As an exploratory study much was learned from this survey about faculty and staff perceptions of the state of crisis preparedness and perceptions about campus training, emergency plans and the level of campus security. Note that these results are not generalizable, but are applicable only to the specific school, faculty and staff surveyed.

A few themes emerged from this survey regarding faculty and staff perceptions about preparedness including

- In general the respondents, both trained and untrained were not very familiar with the safety policies and procedures of the campus including little awareness of utility shutoffs, contingency plans, locations of fire extinguishers and details of the campus disaster plan including the emergency communication plan. Very little of this information was provided at the training session. The one area where there was general familiarity was the location of exits. Trained respondents had superior knowledge of the evacuation plan which was discussed at the training provided by the sheriff's department.
- The respondents, trained and untrained, were confident that the ongoing operations of the campus would not be impeded by a crisis or disaster.
- Faculty and staff, both trained and untrained, expressed the strongly held belief that it would be easy for an intruder to come into the workplace and that both workspaces (offices) and classrooms were not secure. In addition they expressed consensus that an active shooter or other crisis was a real possibility. The feelings of insecurity at work held by trained faculty and staff are worrisome since the training was designed to provide concrete strategies for responding successfully to an emergency such as a shooter on campus. This is consistent with those who point out that open access to college campuses poses a unique security challenge [5].
- The single significant difference between trained and untrained responses related to the belief that individuals could be held personally liable for injury or death associated with a crisis emergency. We speculate that the lower level of agreement expressed by the trained faculty and staff may suggest a greater awareness of the campus personnel and policies protecting the campus in the event of an emergency, and thus reducing the likelihood of personal liability for negative crisis outcomes.
- Another interesting result is that untrained individuals were much more likely to agree with statements indicating a willingness to volunteer or take a leadership role in disaster preparedness. We hypothesized that trained individuals would be motivated by the preparedness presentation to take a more active role, when in reality perhaps they found that someone else was taking responsibility thus lifting the burden from their shoulders.
- Finally, the hypothesis that the training would boost the level of confidence and sense of security for faculty and staff participating in the training was not supported since trained faculty reported that they did not feel safer in their offices and reported feeling significantly less safe in their classrooms after attending the training. This result is likely explained by the research cited above indicating that greater awareness of real danger may increase fear and anxiety [2] [5] [12].

Future research into this topic would include larger sample sizes, more generalizable populations of study and careful refinement of the survey instrument based on lessons learned from this study.

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CAN WE REALLY USE ANY OF THOSE WIDGET EXAMPLES WE LEARNED IN SCHOOL?

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ABSTRACT

This paper looks at the topics of break even analysis, time series analysis, and multiple regression analysis in the context of a personal example dealing with the decision to install a shallow well at my residence and the costs and cost savings after the well was installed. Finding practical examples for the classroom that are believable is critical to the learning process. This simple, but real world example perfectly fits the bill.

INTRODUCTION

As I creep through my 39th and last year as a college professor, I often wonder if the students really think that what we are teaching them is really going to be used in their careers once they graduate from college. Believing that the topics are usable in today's business world is a critical attribute to a successful teaching experience. I believe that accounting and finance topics are easily applicable because students see income statements and balance sheets when they look at an annual report for any Fortune 500 company. If they take the time to dig past the glossy pictures and the CEO's message, they also see the calculation of those wonderful financial ratios.

However the topics in the Operations and Statistical areas seem more cloudy. Once we leave the topic of Inventory Control, I seem to get those questioning looks that say, "Do you really think we will ever use this stuff?" Today's textbooks have all kinds of example problems--all of which are simplified examples of actual corporate happenings, but the looks still read, "Really?" "Seriously?"

Therefore, I have had to dig out an old box of saved bills--city utility bills, and create a real problem. Since this analysis deals with the reduction of city (tap) water usage, a "going green" mentality is also thrust onto the process. This student case is a multi-day, vertically integrated case that students will see as using the learned topics in a real problem--one that they could replicate or modify slightly and use in their business career.

ANALYSIS REQUIREMENTS

This case will require three separate quantitative calculations, two break evens and one regression. The break evens are for the expected recovery of the investment costs and the actual recovery time of the investment costs. The regression is used to predict the on going water bill costs that can be expected after the installation.

VERTICALLY INTEGRATED CASE APPROACH

Table One presents the topics and time frames used in this case.

TABLE ONE

Steps to Perform a Vertically Integrated Research Case

- 1) Presentation of the problem. (class #1)
- 2) Statement of the model--the dependent variable. (class #1)
- 3) Perform a break even analysis to determine how long the investment might require to recoup. If it is going to take 30 years, there is no reason to invest. (class #1)
- 4) Perform a break even analysis post installation to determine more precisely how long to recoup the capital investment. (class #2)
- 5) Hypothesize the quantitative regression model and the relationship of each of the independent variables to the dependent variable (class #2)
*It should be noted that the available independent data is limited to what is recorded over the years. We could not play "Star Trek" and go back in time to collect data.
- 6) Make database available on-line for retrieval and use in an Excel program. (class #3)
- 7) Analyze the data: model validation & statistical tests.
 - a: time series with trend and seasonality (class #3)
 - b: multiple regression using dummy variables included (class #4)
- 8) Draw conclusions--review hypotheses. (class #5)

PRESENTING THE PROBLEM

"My family is interested reducing the water bill with the installation of a shallow well to draw water from the ground aquifer and reduce the usage of expensive city water. In addition to the grass, my wife has an extensive garden that requires much watering. What information do I need to determine if I should install the well?"

After some discussion, mostly by the professor, the class agreed on the following information requirements and desired outcomes:

- 1) The current water bill in dollars over the last 24 months if possible, 12 if not--to wash the seasonality from the data.
- 2) The cost of the well and the pump to be installed (the fixed costs).
- 3) The expected savings once the well is installed (forecast at best of variable cost savings). We will use break even analysis.
- 4) Follow up analysis on how long it will take to recoup the investment cost. We will use break even analysis.
- 5) A forecast of on going water costs. We will use time series and multiple regression analysis.

THE DEPENDENT VARIABLE -- UTILITY BILL IN DOLLARS

In my town water usage is charged on the monthly utility bill. Also included in that bill are the recycle charges, the garbage collection fees, and the sewer rates. The sewer charge is directly related to the amount of city water the customer uses. Therefore if the customer has a well, there will be no water charge and no sewer charge to water the lawn. From this point on “water” represents the charges for water and sewer. Water is charged as a fixed cost each month (small) plus a variable cost charge per 1,000 gallons used. There is no charge until 1,000 gallons are used. The customer simply gets less than 1,000 free for one month and then the charge appears on the next monthly bill. Therefore the bill is “lumpy.” Although slightly affecting the seasonal indexes, the data does not seem to cause damage to the overall models or the interpretation of their meaning. Table Two presents three years of historic water bills.

TABLE TWO

| | <u>Time Frame</u> | | | |
|---|-------------------------------------|-------------------------------------|-------------------------------------|-------------|
| <u>Month (from)</u> <u>(through)</u> | <u>Feb 2009-</u> <u>Jan 2010</u> | <u>Feb 2010-</u> <u>Jan 2011</u> | <u>Feb 2011-</u> <u>Jan 2012</u> | |
| February | 112.13 | 102.90 | 97.57 | Grand Total |
| March | 82.85 | 92.42 | 97.57 | \$4,624.18 |
| April | 112.13 | 123.86 | 176.67 | |
| May | 188.85 | 186.74 | 165.37 | divided by |
| June | 112.13 | 216.12 | 176.67 | 36 months |
| July | 102.49 | 144.82 | 131.47 | |
| August | 102.49 | 134.34 | 142.77 | equals |
| September | 92.85 | 113.38 | 154.07 | \$128.45 |
| October | 130.67 | 154.07 | 127.50 | per month |
| November | 123.86 | 131.47 | 127.60 | |
| December | 102.90 | 108.87 | 115.31 | |
| January | 102.90 | 108.87 | 127.50 | |
| 12 Month Total | 1366.25 | 1617.86 | 1640.07 | |

INVESTMENT COST AND SAVINGS

The installation of the well included two bills: \$1,125 for American Well and Irrigation for the well, installation of the well and pump motor. The other bill was an electrical bill for installation and wiring of a circuit to juice the pump. That cost was \$350 from Limbaugh Electric. This was a total of \$1,475 invested before the first gallon of water could be pumped.

The cost savings estimate was determined in a loose survey approach. I simply went to all of my neighbors and asked them if they could guess at the cost reduction when they installed their well. The range was extensive--from 25% to 40%, with the largest frequency at 30%. This "reduction" included the bill total, not the reduction of the water and sewer portion of the charge. The expected bill after installation is shown in equation (1):

$$\$89.91 = \$128.45 * 0.70 \quad (1)$$

USING BREAK EVEN ANALYSIS

The first quantitative calculation is to determine the number of months to recover the investment costs.

$$\begin{aligned} \text{Cost Equation pre-installation:} \quad & \text{Total Amount Paid} = \$128.45 * X \quad (2) \\ \text{where: } X & \text{ is the number of months} \end{aligned}$$

$$\text{Cost Equation post-installation:} \quad \text{Total Amount Paid} = \$1,475 + \$89.91 * X \quad (3)$$

Setting the equations equal to each other will determine the indifference point or the number of months to recover the investment.

$$\$128.45 * X = \$1,475 + \$89.91 * X \quad (4)$$

$$\$1,475 / \$38.54 = 38.27 \text{ months} \quad (5)$$

Therefore a little over three years to recover the investment. Most assets in a business are depreciated over three to five years. Thus 38 months seems like a very reasonable number. And we used a technique that is taught in many classes that our students have learned.

TABLE THREE

Time Frame After Well Installation

| Month (from) (through) | Feb 2012- Jan 2013 | Feb 2013- Jan 2014 | Feb 2014- Sept 2014 | |
|---------------------------|-----------------------|-----------------------|------------------------|---|
| February | 73.93 | 109.09 | 89.98 | Grand Total first 12 months \$915.63 divided by 12 months equals \$76.30 |
| March | 54.47 | 135.39 | 125.12 | |
| April | 54.47 | 109.09 | 89.98 | |
| May | 54.47 | 122.24 | 125.12 | |
| June | 54.47 | 109.09 | 125.12 | |
| July | 54.47 | 98.61 | 100.78 | |
| August | 83.66 | 111.07 | 111.58 | |
| September | 54.47 | 109.09 | 100.78 | |
| October | 88.13 | 100.28 | | |
| November | 122.24 | 111.58 | | |
| December | 122.24 | 100.78 | | |
| January | 98.61 | 138.66 | | |
| 12 Month Total | 915.63 | | | |

POST INSTALLATION USING BREAK EVEN ANALYSIS

A follow-up break even analysis was performed 12 months after the well went into service.

Actual Cost Equation post-installation:

$$\text{Total Amount Paid} = \$1,475 + \$76.30 * X \quad (6)$$

Using equation (2) and (6) we can find the “actual” months to recapture the investment costs:

$$\$128.45 * X = \$1,475 + \$76.30 * X \quad (7)$$

$$\$1,475 \quad / \quad \$52.15 = \quad 28.23 \text{ months} \quad (8)$$

This well was a really good investment! The class cheers! We again used a quantitative method learned in class to solve an actual problem. Everyone was feeling pretty good until we looked at all of the post installation data as presented in Table Three. Immediately after well installation the water bills went down markedly, as expected. However, they returned to a higher level and over the next two years were double what the immediate months following installation. What is this all about?

An inquiry to the city revealed the explanation. Within one month of well installation the water meter stopped functioning. I did not know this and the city did not realize this for six months. When they found the problem, they installed a new water meter. The readings were corrected during the month of October, 2012.

This coincidence made the forecasting of future bills very interesting and much more difficult. More thinking about a forecasting model was required. The model is presented in Table Four.

TABLE FOUR

Independent Variables and Hypotheses

| <u>Independent Variable #</u> | <u>Independent Variable Group</u> | <u>Hypothesis(increase/decrease)</u> |
|-------------------------------|--------------------------------------|--------------------------------------|
| 1 | Time | Decrease (going green) |
| 2-13 | Seasonality(months) | Sine Curve |
| 14 | Dummy variable for Well Installation | Big Decrease |
| 15 | Dummy variable for Faulty Meter | Negative Number |

DISCUSSION ABOUT INDEPENDENT VARIABLES

There are two independent variables, Time and the Well. A total of 60 months of data is used in the model, 32 months after the installation and 28 months before the installation. Using monthly seasonal indexes in a time series model is very easy. However, when the second independent variable is added, the well, then a multiple regression model is required to handle the dummy variable. To make matters worse, a second dummy variable is added to identify the months when the meter was not functioning and the water bills were artificially low.

Calculating seasonality in a multiple regression model is a much more difficult process. At first glance merely doing a trend model with the addition of the dummy variables for the two critical events may be sufficient to create a good model. However, in Florida, there is seasonality of water usage and it is deemed essential to forge ahead with the more difficult multiple regression model.

The first two models will be time series models. First, a simple time series model using only a trend component, hopefully with a negative B-coefficient and a second time series model that includes trend and seasonal components. Students have studied time series models in previous courses.

A FIRST MODEL -- A SIMPLE TIME SERIES WITH TREND

The class is prepared to start the analysis process. The data, all 60 months is stored in a file for student access. Table Five presents the statistical analysis for the trend model

TABLE FIVE

| <u>Trend Model of KWH Usage per Day</u> | |
|---|--------------------|
| B-zero | \$131.048 |
| B-one | -\$0.54954 / month |
| Standard Deviation | \$31.56735 |
| R-square | 0.085943 |

This model reveals statistically poor results with an extremely weak R-square. However, the B(1) coefficient is negative, although a very small number of minus 54 cents per month. It is important to define in English the meaning of the various numbers before we move to the next and more involved model.

The B(0) of \$131.048 represents a lot of costs: garbage, sewer, recycling, and the fixed component of the water charge. The B(1) represents the increase or decrease in the cost and/or the increase in usage of water per month plus any increases in other costs that are part of the utility bill. Although there have been some cost increases in garbage collection and recycle fees, these have been very small as compared to the increases in the cost of water per thousand gallons. Therefore the negative value of \$0.54 per month reflects two things: 1) the decrease in the use of city water, and 2) any increase in the cost of that water. It is virtually impossible to use actual water used as the dependent variable because of the lumpy billing and small numbers of the 1000s of gallons of water used. Students need to learn that sometimes the “perfect” variable is not easily obtained and compromises must be made if you want any model.

ACCOUNTING FOR SEASONALITY

Seasonality in a time series model is straight forward. Seasonality in a multiple regression is far more complicated and takes several steps. The steps and results are described below. The results for both the Time Series model with seasonal indexes and the Multiple Regression model with seasonal indexes are presented in Table Six.

Step 1: Develop a matrix of 11 dummy variables--October through August--for this case. There is no September dummy variable. Thus when the computer calculates the B-coefficients for each of the eleven months, that figure is the difference between the particular month and September. For example, the August index from the computer program is 9.75609. This means that the use-of-water cost coefficient in August is 9.75609 (per month) greater than in September. Thus to calculate the additive seasonal indexes so that we can talk about the usage in August relative to August, more steps are required.

Step 2: Add up the values of the eleven B-coefficients, October through August. For this case, that summation is 57.535916. The 12th month, September, is given a seasonal index value of 0.0. Divide this summation by the 12 months. This average is 4.79465967.

Step 3: Subtract 4.79465967 from each of the twelve seasonal indexes (11 from the computer output plus September) and add 4.79465967 to the B-zero value (126.8742) to become 131.669. September's index becomes -4.794659.

Table Six presents the numerical results of the above three steps and the statistical measures from the computer output.

TABLE SIX

Two Models that Considers Trend and Seasonality

| <u>Measure or Variable</u> | <u>Trend & Seasonal Model Multiple Regression Model</u> | <u>Trend & Seasonal Time Series Model</u> |
|----------------------------|---|---|
| B-zero | \$131.669 | \$131.048 |
| B-one | \$-0.5699 /month | \$-0.54954 /month |
| Standard Deviation | 32.48789 | 29.24744 |
| R-square | 0.21547 | 0.215356 |
| F-statistic | 1.07506 | |
| Sum of Squares Regression | 13624.41 | 13617.24 |
| Sum of Squares Error | 49606.76 | 49613.93 |
| Sum of Squares Total | 63231.17 | 63231.17 |
| | <u>Seasonal Index</u> | <u>Seasonal Index</u> |
| October | +2.70833 | +2.820387 |
| November | +6.50024 | +6.591923 |
| December | -6.26185 | -6.19054 |
| January | -0.40394 | -0.35301 |
| February | -20.46806 | -20.4375 |
| March | -13.57812 | -13.5679 |
| April | -3.18821 | -3.1984 |
| May | +17.35570 | +17.32514 |
| June | +23.43161 | +23.38067 |
| July | -6.26248 | -6.33379 |
| August | +4.96143 | +4.869744 |
| September | -4.79466 | -4.90672 |

The two models are very similar. The difference must be in the actual calculation equations. The measures of performance show improvement in the model versus the Trend model. However we have not looked at the key independent variable in this study: the well and water pump and the dummy variable of the broken water meter. The B-zero and B-one coefficients are very similar. That is expected. The R-square for the seasonal model has almost tripled. However for a model using aggregate data, the measures are still very weak. We must consider the two additional variables!

The numeric values of the seasonal indexes seem to “bounce around a lot.” This could be because of the lumpy billing. It could just be because of the rain cycles in Florida. At least on average the Winter months show the lowest amount of watering. This is very reasonable. The

next step to account for the critical event--installation of the well and the water pump presented in Table Four. We will not consider the broken meter in the next model, rather try to improve the model incrementally.

CONSIDERING THE WELL INSTALLATION

The dummy variable is added to show at what month the well was installed (month and observation #29) and is given the value of “1” while all previous months are given the value of “0”. Column N in the Excel template contains the well installation dummy variable. The results are shown in Table Seven.

TABLE SEVEN

Taking Into Account the Installation of the Well

| <u>Measure or Variable</u> | <u>Trend & Seasonality Multiple Regression</u> | <u>Trend & Seasonality Multiple Regression</u> |
|----------------------------|--|--|
| | <u>Well and Pump Installation</u> | |
| B-zero | \$115.131457 | \$131.669 |
| B-one | \$1.2375/month | \$0.5699 /month |
| Standard Deviation | 25.87192 | 32.48789 |
| R-square | 0.51305 | 0.21547 |
| Adjusted R-sqr | 0.37543 | 0.01516 |
| F-statistic | 3.728125 | 1.07506 |
| Sum of Squares Regression | 32440.78 | 13624.41 |
| Sum of Squares Error | 30790.4 | 49606.76 |
| Sum of Squares Total | 63231.17 | 63231.17 |
| Well Installation | -72.2964 | |
| | <u>Seasonal Index</u> | |
| October | +3.009563 | +2.70833 |
| November | +4.994063 | +6.50024 |
| December | -9.575435 | -6.26185 |
| January | -5.524935 | -0.40394 |
| February | -12.937157 | -20.46806 |
| March | -7.854657 | -13.57812 |
| April | +0.727843 | --3.18821 |
| May | +19.464343 | +17.35570 |
| June | +23.732843 | +23.43161 |
| July | -7.768657 | -6.26248 |
| August | +1.647843 | +4.96143 |
| September | -9.915657 | -4.79466 |

The statistics of the model that includes the well installation dummy variable is better than the model without. The R-square is 0.51 versus 0.21. More properly, the Adjusted R-square improved greatly from 0.01 to 0.37. The 0.01 should alert the model builder to a serious

predictive problem. With the inclusion of the well, the measures or performance are much improved.

However, there is one final step to include in the model, the dummy variable for the months when the water meter was not functioning. Before this fact was known, it could be interpreted that the installation of the well and pump saved an average of \$72.296 per month. Although I was doing back flips, that number is too good to be true. With the inclusion of the second dummy variable, the model shows that it was.

Table Eight includes the final two models, the one with the dummy for the broken water meters as well as the dummy for the well installation and is compared to the model with just one dummy variable.

TABLE EIGHT

Taking Into Account the Broken Water Meter

| <u>Measure or Variable</u> | <u>Trend & Seasonality Multiple Regression Well & Pump Broken Water Meter</u> | <u>Trend & Seasonality Multiple Regression Well & Pump Installation</u> |
|----------------------------|---|---|
| B-zero | \$129.12025 | \$115.131457 |
| B-one | \$0.276217 | \$1.2375/month |
| Standard Deviation | 22.79797 | 25.87192 |
| R-square | 0.630109 | 0.51305 |
| Adjusted R-square | 0.515032 | 0.37543 |
| F-statistic | 5.475538 | 3.728125 |
| Sum of Squares Regression | 39842.54 | 32440.78 |
| Sum of Squares Error | 23388.63 | 30790.4 |
| Sum of Squares Total | 63231.17 | 63231.17 |
| Well Installation | -31.4418 | 72.2964 |
| Meter Broken | -43.2578 | |
| | <u>Seasonal Index</u> | <u>Seasonal Index</u> |
| October | +5.33265 | +3.009563 |
| November | +8.27844 | +4.994063 |
| December | -13.98132 | -9.575435 |
| January | -8.96954 | -5.524935 |
| February | -23.59135 | -12.937157 |
| March | -8.89605 | -7.854657 |
| April | +0.64773 | +0.727843 |
| May | +20.34552 | +19.464343 |

| | | |
|-----------|-----------|------------|
| June | +25.57530 | +23.732843 |
| July | -4.96492 | -7.768657 |
| August | +5.41287 | +1.647843 |
| September | -5.18935 | -9.915657 |

The statistical measures of performance are improved with the adjusted R-square improving from 0.37 to 0.51. There was a huge change in the value of B(1)--the increase in water bill per month, from \$1.23 to a very small \$0.27. That makes me feel much better since one of the goals was to use much less water. The broken water meter reduced the bill an average of \$43.26 per month. The eight months with a broken water meter saved about \$346. The savings due to the well installation averages \$31.44 per month and that should continue forever!

One final break even analysis is performed to determine, now with good data, how many months it will take to recover the investment.

$$\begin{aligned}
 \text{Total Investment Cost} &= \$1,475 \\
 \text{Average Savings Per Month} &= \$31.44 \quad * \quad X \\
 \\
 \$1,475 / \$31.44 &= X = 46.9 \text{ months} \quad (9)
 \end{aligned}$$

Not 28 months as previously calculated, however, still under five years. Now my wife can water her flowers and bushes to her heart's content and really not worry about spending a lot of money.

USING THE MODEL

The final step is to use the model to predict the utility bill for the next month, October 2014. Student learning is not complete until the calculated and statistically validated model is USED to calculate the dependent variable, the water bill. All models were included, to look at the differences in prediction.

$$\text{Trend model:} \quad \$98.08 = 131.048 - 0.54954 * 61 \quad (10)$$

$$\begin{aligned}
 &\text{Seasonal Model} \\
 \text{Time Series:} \quad & \$100.90 = [131.048 - 0.54954 * 61] + 2.820 \quad (11)
 \end{aligned}$$

$$\begin{aligned}
 &\text{Seasonal Model} \\
 \text{Multiple Regression:} & \$100.19 = [131.669 - 0.5699 * 61] + 2.71 \quad (12)
 \end{aligned}$$

$$\begin{aligned}
 \text{Well Installation:} &= [115.13 + 1.2375 * 61] + 3.009 \\
 &\quad - 72.2964 (1) \\
 \$118.32 &= 115.13 + 75.4875 - 72.2964 \quad (13) \\
 \text{Well Installation} &= [129.12 + 0.2762 * 61] + 5.33 \\
 + \text{Broken Meter} &\quad - 31.4418 (1) - 43.25 (0)
 \end{aligned}$$

$$\$119.86 = 129.12 + 16.848 + 5.33 - 31.44 \quad (14)$$

Personally, I was hoping for monthly bills under \$100. But no such luck!

CONCLUSION

The time had finally come to wrap it all up. As a class we had come a long way. The goal of learning was reinforced by the process of discovery. When everyone is involved in building the model, meaningful learning becomes a more pleasant experience. The interaction of the students, the professor, and the database itself made the project interesting and engaging. We are not spoon fed a sterilized, meaningless, widget model. And, yes, students learned that the models we teach them are very applicable to a REAL problem. Finally, even though it is challenging material, the class managed to have fun with it! Here are a few reasons why this case is such an effective method of learning:

- 1) The data is real and timely.
- 2) The situation is realistic and not just a “classroom exercise.”
- 3) Students are encouraged and expected to interact throughout the case.
- 4) The computer is used extensively
- 5) Sophisticated models are developed using the computer.
- 6) Many steps are needed to reach a conclusion.
- 7) There is not one clean, final answer, thus reinforcing the “real” idea of the case.
- 8) The students enjoyed the realistic and far-reaching discussions.
- 9) When it makes sense, it sinks in!

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WHAT FIRST YEAR STUDENTS KNOW AND DON'T KNOW ABOUT COMPUTER CONCEPTS 2004-2014

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ABSTRACT

Many high school graduates today have had experience with smart phones, iPads and social media. Many university administrators have suggested that high school graduates already know everything about computers so there is no need for a university to offer an introductory computer course. University faculty who teach introductory computer courses know that many first year students have a very limited knowledge about computers. This paper will provide some data to establish what high school graduates know about computer concepts. This paper provides the results of 10 years of testing about computer concepts and shows that most students still know very little about computer concepts.

BACKGROUND

A computer literacy course has been taught for many years for non computer, business or engineering university students. There has been an ongoing discussion of whether a computer literacy course is still needed. Engel (10), Baron (2), Clements (4), Sloan (22), Cohen (5), Peterson (19), Sellers (21), Smith (23) were some of the many people concerned with computer literacy 20-40 years ago. More recently there have been articles by Easton (9), Case (3), Dyer (8), Hoffman (13), Hoffman (14), Werner (27), Foster (11), Gupta (12), Liao (15), Bannerjee (1), Tsui (25), Van Vliet (26) and others, discussing various aspects of computer literacy in today's society. Pierce (20), Werner (27), Stiller (24), Gupta (12), Bannerjee (1), Dednam(7) have been concerned with the changes in computer literacy in the light of our rapidly changing technology.

A very recent study by Day (6), tested the Microsoft Office knowledge of first year students. The results were an average score of 34%, which also indicates that the computer background of current high school graduates is still not what might be hoped for. The Day study is an extensive study which also compares online vs. face-to-face, women vs. men and full time faculty vs. adjunct faculty.

INTRODUCTION

Since 2004 the authors of this paper have given a Course Test Out Quiz by Course Technology (CT) during the first week of the first year computer concepts course. Students are offered extra credit if they complete this CT quiz. The authors of this paper have been surprised at how enthusiastic students have been to earn extra credit. This Test Out Quiz was offered on WebCT in 2004 and on Folio (d2l) in 2013 and 2014.

This 160 question test covers the 15 chapters shown in Table 1 below.

| Chap | Chapter Title |
|------|---|
| 1 | Introduction to Computers |
| 2 | The Internet and the World Wide Web |
| 3 | Application Software |
| 4 | The Components of the System Unit |
| 5 | Input |
| 6 | Output |
| 7 | Storage |
| 8 | Operating Systems and Utility Programs |
| 9 | Communications and Networks |
| 10 | Database Management |
| 11 | Computers and Society, Security, Privacy and Ethics |
| 12 | Information System Development |
| 13 | Programming Languages and Program Development |
| 14 | Enterprise Computing |
| 15 | Computer Careers and Certification |

Table 1: Content Areas Addressed in the Computer Literacy Assessment Test

The average per cent correct for 2004, 2013 and 2014 are shown in Table 2 below.

| Chapt | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Class Avg |
|---------------------------|----|----|----|----|----|-----|-----------|----|----|----|----|----|----|----|----|------------------|
| Avg % Correct 2004 | 65 | 49 | 50 | 51 | 52 | 58 | 49 | 40 | 39 | 48 | 50 | 36 | 27 | 39 | 31 | 49% |
| Avg% Correct 2013 | 61 | 54 | 54 | 51 | 52 | 58 | 39 | 41 | 46 | 54 | 51 | 36 | 29 | 41 | 33 | 46% |
| Avg% Correct 2014 | 57 | 51 | 54 | 60 | 48 | 43 | 45 | 39 | 42 | 50 | 45 | 41 | 34 | 33 | 39 | 43 |
| Diff 14-04 | -8 | 2 | 4 | 9 | -4 | -15 | -4 | -1 | 3 | 2 | +5 | 5 | -3 | +6 | 8 | -6% |

Table 2: Average Per Cent Correct 2004, 2013 & 2014

Out of 160 questions in 2004 the average of correct answers was 49% and in 2013 it was 46% and in 2014 it was 43%. It is obvious that the students’ knowledge about computer concepts is not impressive. It would not be true to say that these students have a sound knowledge of computer concepts. From this data it is obvious that there are still students that can benefit from a computer literacy course.

COMPUTER KNOWLEDGE BY AREA

Table 3 below shows the content area results in the Computer Literacy assessment test. From Table 3 it can be seen that students have a better computer knowledge in some areas than in other areas. In 2014 it can be seen that Chapter 4, “The Components of the System Unit” had the highest average score and the worst score in 2014 was in Chapter 14 “Enterprise Computing”. Appendix A contains a listing of the topics in Chapter 4 and Appendix B contains a listing of the contents of Chapter 14. It should be noted that the average quiz scores were failing in all areas. In Table 3 below the average scores in the test are sorted from best to worst.

| Chap | Chapter Title | 2014 Avg |
|-------------|---|-----------------|
| 4 | The Components of the System Unit | 60 |
| 1 | Introduction to Computers | 57 |
| 3 | Application Software | 54 |
| 2 | The Internet and the World Wide Web | 53 |
| 10 | Database Management | 50 |
| 5 | Input | 45 |
| 7 | Storage | 45 |
| 11 | Computers & Society, Security, Privacy & Ethics | 43 |
| 6 | Output | 42 |
| 9 | Communications & Networks | 41 |
| 12 | Information System Development | 39 |
| 8 | Operating Systems & Utility Programs | 39 |
| 15 | Computer Careers and Certification | 34 |
| 13 | Programming Languages & Program Development | 34 |
| 14 | Enterprise Computing | 33 |
| | Average | 45 |

Table 3: The Chapters Sorted By the Highest Average Score for 2014

Table 4 has the average scores sorted from worst to best for 2014.

| Chap | Chapter Title | 2014 Avg |
|-------------|---|-----------------|
| 14 | Enterprise Computing | 33 |
| 13 | Programming Languages & Program Development | 34 |
| 15 | Computer Careers & Certification | 34 |
| 8 | Operating Systems & Utility Programs | 39 |
| 12 | Information System Development | 39 |
| 9 | Communications & Networks | 41 |
| 6 | Output | 42 |
| 11 | Computers & Society, Security, Privacy & Ethics | 43 |
| 7 | Storage | 45 |
| 5 | Input | 45 |
| 10 | Database Management | 50 |
| 2 | The Internet and the World Wide Web | 53 |
| 3 | Application Software | 54 |
| 1 | Introduction to Computers | 57 |
| 4 | The Components of the System Unit | 60 |

Table 4: The Chapters Sorted By the Lowest Average for 2014

CONCLUSION

The results in these tables confirm what most university professors teaching intro computer courses already know, that high school graduates, in spite of smart phones, iPads and social media, do not have a good knowledge about computers. From Tables 2, 3 and 4 it can be seen that students do have some knowledge in many computer areas however, there is a lot about computers that they do not know. It appears that it is too early to declare the demise of a computer literacy course.

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APPENDIX A

Chapter 4 The Components of the System Unit

The System Unit

Processor

Data Representation

Memory

Computer Slots and Adapter Cases

Ports and Connectors

Buses

Bays

Power Supply

Mobile Computers and Devices

Putting it All Together

Keeping your Computer Clean

Chapter Summary

High-Tech Talk

Companies on the Cutting Edge

Technology Trailblazers

APPENDIX B

Chapter 14 Enterprise Computing

What is Enterprise Computing

Information Systems in the Enterprise

Enterprise wide Technologies and Methodologies

E-Commerce

Enterprise Hardware

Backup Procedures

Chapter Summary

High-Tech Talk

Companies on the Cutting Edge

Technology Trailblazers

An Example for Teaching Trouble Shooting in a Management Science Course

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Abstract

Individual students typically receive feedback on graded work about their modeling mistakes in a quantitative management course. This paper presents an example for formal instruction of trouble shooting issues for model formulation and writing in an undergraduate management science course. The goal is to help novices recognize a number of common mistakes in model formulation and the accompanying written documentation for a business problem.

Introduction

Two common problems faced by novice model builders are difficulties in identifying their modeling mistakes (Brown & Dell 2007; Stevens & Palocsay, 2004) and problems in communication (Grossman, Norback, Hardin, & Forehand, 2008). Research on model building and communication have usually been in separate venues. However, both skills benefit when students repeatedly receive feedback and have multiple opportunities to practice modeling and communication skills to improve future work. As such, researchers in each area will benefit by sharing best practices for giving feedback. One example of a best practice for coaching expert skill is based on the work of Ericsson, Krampe, and Tech-Romer (1993), who define *deliberate practice* as learning activities in which learners focus attention on difficult aspects of a task and future practice is structured and guided by feedback that informs students on specific areas that need work and provides guidance on how students might improve.

Teaching model formulation is challenging. Whole problems can be presented to novices (Stevens & Palocsay, 2004) or individual modeling components (Brown & Dell 2007). Brown and Dell (2007) present common mistakes, including constraint coefficient errors and operator errors, along with corrections in their individual component approach. After providing instruction on common modeling constructs, Dombrowskaia and Guzman (2006) found that students performed over 19 iterations on average in order to build an executable production model. An important component of analytical work in practice is the quality of the associated communication (Grossman, Norback, Hardin, & Forehand, 2008). Common writing mistakes include omission of the business context (for example, omission of components of the problem statement), the decision, the objective, some of the constraints, and/or the modeling approach when students write about their business problem and the challenges they experience when building a business model.

Instructors often provide feedback to individual students about each formulation mistake on homework assignments, quizzes, and tests. Likewise, when instructors include writing about analytical work in a business course, they may give students individual feedback on writing mistakes (Carrithers & Bean, 2008; Williams & Reid, 2010). Figure 1a shows the typical model for an

individual student who receives feedback from the instructor on modeling mistakes the student made on homework, quizzes, and tests. One disadvantage of giving individual feedback is that students are not exposed to the full variety of trouble shooting issues. Individual feedback on modeling is limited to the types of trouble shooting problems manifested in the individual student's work. When feedback is provided only as part of the grading process, students do not receive instructive feedback until after their assignment is graded. Feedback given as part of a summative assessment (e.g., a grade on a final project) arrives too late to improve skill or learning for a struggling student. Feedback is most effective when students have an opportunity to apply the feedback to future work and improve their skills (Ambrose, et al., 2010; Chickering & Gamson, 1991; Hattie & Timperley, 2007; Nilson, 2013). Another approach that enables students to receive timely feedback and use feedback to improve future work is one in which the instructor provides formal instruction to all students early in the course. The feedback describes common errors students make during trouble shooting and describes how students can avoid making these errors, as is illustrated in Figure 1b.

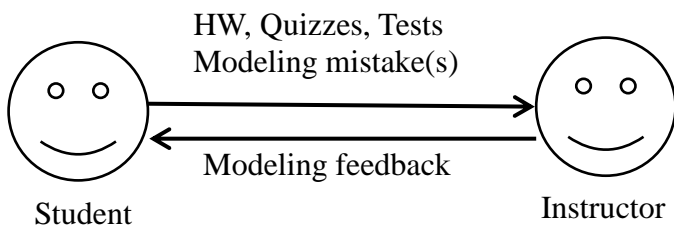


Figure 1a. Typical model for individual student feedback on modeling

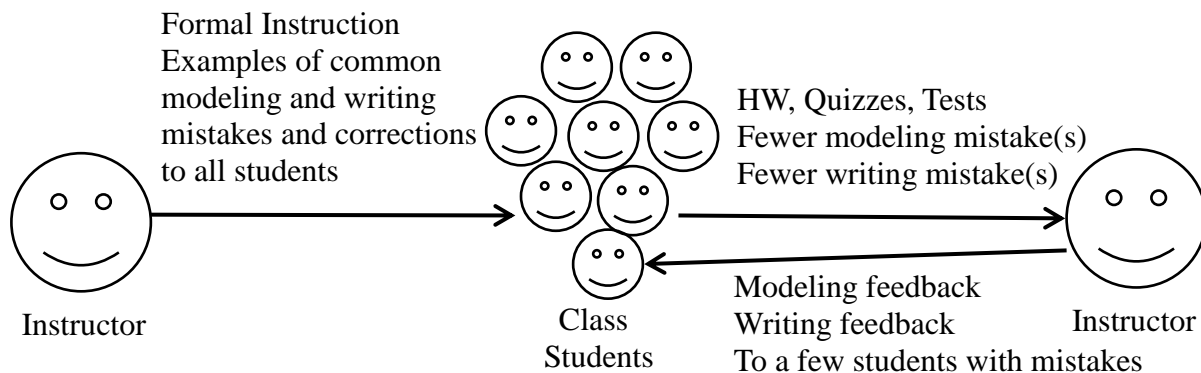


Figure 1b. Proposed model for formal instruction on common modeling and writing mistakes and corrections for all students and subsequent feedback for individual students still struggling

In figure 1b, all students in the class receive formal instruction during the class lecture with an example of common model formulation errors and communication mistakes as well as an example that shows corrections for these problems. This example can integrate both model formulation errors and writing mistakes and illustrate how these problems can be corrected. The goals of the formal instruction during lecture time are to lessen the struggle students experience with model building,

lessen the number of modeling and writing mistakes on future work, and help students learn to find and correct their own mistakes, similar to teaching students how to edit their own writing.

This paper provides an example of an assignment that teaches students about common formulation and communication trouble shooting problems and explains how students can avoid these problems. It is intended for use early in an undergraduate course in management science. Although this assignment was developed for an undergraduate management science course, the general strategy in which instructors provide an example that illustrates incorrect problem solving and communication elements and explains how to correct these problems could be applied to other business courses. These analytical and communication skills are an integral part of standard 15, Management of Curricula, of the AACSB 2013 accreditation requirements (AACSB, 2013).

Example Teaching Instrument

The formal instruction for trouble shooting issues and corrections is an example composed of four memos. We selected the memo format for the business scenario and follow-up communications to align with expectations students will encounter in a professional writing situation. The four memos are summarized in Table 1.

Table 1. Structure of the Teaching Instrument: Trouble Shooting Issues and Corrections

| Memo Number | Description of Memo |
|-----------------------------------|---|
| Initial Communication | |
| Memo 1 | Memo from manager describing the business scenario |
| Memo 2 | Memo from intern with multiple writing and model formulation mistakes |
| Follow-up & Revised Communication | |
| Memo 3 | Memo from business coach describing mistakes |
| Memo 4 | Corrected memo from intern with corrected writing and corrected model |

Memo 1 contains the details about the business scenario, including the decisions that the manager faces, the request for a recommendation, the manager’s objective, and the constraints that make the manager’s problem challenging. Memo 2 contains multiple writing and business modeling mistakes that a typical novice might make. Memo 3 contains coaching from an experienced business analyst and includes a list of the writing and modeling mistakes that should be addressed for trouble shooting. Memo 4 is a corrected memo from the intern that includes a brief description of the problem, the manager’s objective, the constraints on the business problem, a corrected and well-annotated model that could be used to develop a recommendation, and the follow-up comment that the model could be revised for multiple business scenarios. The example containing each of these memos is provided in the appendix for this paper.

Future Research and Conclusions

Future research includes refining the example developed to improve teaching success for problem formulation and communication trouble shooting skills. The authors plan to develop additional

examples for trouble shooting modeling and communication errors since research has shown that repeated problem solving experiences enhance student learning (Mukherjee, 2002). Future research also includes developing assessment tools to evaluate students formally on their troubleshooting skills for problem formulation and business writing.

In conclusion, students may benefit from receiving formal instruction on trouble shooting and avoiding common errors in building business models and writing about them. This paper presents the first example of integrated trouble shooting issues for model formulation and writing in an undergraduate management science course. This concept can be expanded to other business disciplines.

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APPENDIX Management Science 2-page handout
 Communication and Formulation Trouble Shooting Issues - Example 1

The first memo is the original production planning memo that describes the production planning problem.
 The second memo is the response memo submitted by the new intern.
 The third memo is from an experience management science describing the mistakes in the intern's memo.
 The fourth memo is the corrected memo from the intern.

MEMO 1: ORIGINAL PRODUCTION PLANNING MEMO

DATE: September 9, 2014

TO: Management Intern

FROM: UMC General Manager

RE: UMC production plan

Using the information below, develop a model to determine the number of Parejo, Torpedo, and Perfecto units to produce and sell that maximizes profit.

Marketing UMC has 3 products for sale: the Parejo, the Torpedo, and the Perfecto. At least 250 units of Perfecto are required. No more than 150 units of the Torpedo can be sold.

Accounting The profit is \$5 for each Parejo, \$5 for each Torpedo, and \$7 for each Perfecto.

Production There are 4 steps in the production process with the following production times (minutes) and availabilities:

| Process Step | Production Times (minutes) | | | Total Time available (hours) |
|--------------|----------------------------|---------|----------|---------------------------------|
| | Parejo | Torpedo | Perfecto | |
| Cutting | 5 | 2 | 4 | 150 |
| Machining | 2 | | 2 | 100 |
| Fitting | 3 | 5 | 1 | 120 |
| Polishing | 4 | 6 | 4 | 120 |

MEMO 2: INTERN'S FIRST RESPONSE MEMO

DATE: September 12, 2014

TO: UMC General Manager

FROM: Management Intern

Re: Production Plan Formulation Problems

I am stuck. Please advise.

X1 = Parejo produced and sold;

X2 = Torpedo produced and sold;

X3 = Perfecto produced and sold;

- $5X_1 + 5X_2 + 7X_3$
 1) $5X_1 + 2X_2 + 4X_3 \leq 150$ Cutting time
 2) $2X_1 + \quad \quad 2X_3 \leq 100$ Machining time
 3) $3X_1 + 5X_2 + 1X_3 \leq 120$ Fitting time
 4) $4X_1 + 6X_2 + 4X_3 \leq 120$ Polishing time
 5) $\quad \quad \quad 1X_3 \geq 250$ Perfecto requirement
 6) $\quad \quad 1X_2 \quad \quad \geq 150$ Torpedo prod limit

APPENDIX Management Science 2-page handout (continued)
 Communication and Formulation Trouble Shooting Issues - Example 1

MEMO 3: TROUBLE SHOOTING FEEDBACK MEMO

DATE: September 15, 2014
 TO: Management Intern
 FROM: Management Scientist
 CC: UMC General Manager
 Re: Production Plan Formulation Problems

First, your memo does not state the problem (decisions, objective, and constraints), which makes it difficult to understand the context of your problem.

Second, your memo does not state the nature of your problem (modeling mistake? missing data?)

Third, your model formulation has multiple mistakes which include:

- 1) missing units in the legend
- 2) missing "MAX" in the objective function and a label designating profit goal with units
- 3) missing units in each constraint description
- 3) units mismatch between the left-hand (minutes) and right-hand (hours) sides in constraints 1, 2, 3, and 4
- 4) incorrect operator in constraint 7
- 5) non-negativity constraint 7 missing

If you have any additional questions, please contact me.

MEMO 4: INTERN'S SECOND RESPONSE MEMO

DATE: September 16, 2014
 TO: UMC General Manager
 FROM: Management Intern
 Re: Production Plan Formulation Problems

After receiving coaching from a Management Scientist, I am pleased to respond to your request to develop a model to determine the number of Parejo, Torpedo, and Perfecto units to produce and sell in order to maximize profit subject to machine availability schedules and marketing requirements. I developed a linear programming model and provide it in the appendix below. This model can be solved in a linear programming solver and edited for various business scenarios (e.g. different machine availability schedules or different marketing forecasts). Please let me know which scenarios interest you.

APPENDIX: UMC Production Planning Model

X1 = # of units of Parejo to produce and sell
 X2 = # of units of Torpedo to produce and sell
 X3 = # of units of Perfecto to produce and sell

MAX $5X1 + 5X2 + 7X3$

S.T. 1) $5X1 + 2X2 + 4X3 \leq 9000$

2) $2X1 + 2X3 \leq 6000$

3) $3X1 + 5X2 + 1X3 \leq 7200$

4) $4X1 + 6X2 + 4X3 \leq 7200$

5) $1X3 \geq 250$

6) $1X2 \leq 150$

7) $X1, X2, X3 \geq 0$

Maximize profit (\$)

Cutting time (minutes)

Machining time (minutes)

Fitting time (minutes)

Polishing time (minutes)

Perfecto marketing forecast requirement (units)

Torpedo marketing forecast limit (units)

Non-negativity (units)

What Can Virtual Behavior Offer to Entrepreneurship Education?

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Abstract

This paper is motivated by three major, recent trends. 1) The increase in entrepreneurship education. 2) The increase in the use of simulations in the classroom. 3) The rise of virtual entrepreneurship, particularly in the virtual world, Second Life. Second Life has the ability to enhance entrepreneurship education, in the same way simulations enhance education. This study is intended to highlight the commonalities between traditional and virtual entrepreneurship, and provide a foundation for the development of entrepreneurship education in Second Life. The Entrepreneurial Attitudes Orientation (EAO) survey mechanism was used to identify entrepreneurial propensity among virtual entrepreneurs, and to provide a basis for comparison with traditional entrepreneurs. The preliminary results suggest that virtual entrepreneurs demonstrate high levels of entrepreneurial intentions.

Introduction

Support for effective entrepreneurship education and training (EET) from governmental and academic areas has grown over the past few years. Audretsch *et al.* (2006) strongly linked governmental support for entrepreneurship to higher rates of economic growth. As a result of these types of findings, universities are encouraging EET not only for business students but for many other majors. Forty years ago there were only a handful of universities offering entrepreneurship related courses and this has increased to over 3000 schools (Morris, Kuratko and Cornwall 2013). Also, many other majors are encouraging minors in entrepreneurship. Artists as well as engineers and computer scientists are encouraged to learn the fundamentals of creating and managing an entrepreneurial venture. Many artists open galleries and manage exhibitions to “market” his or her work. Computer scientists and engineers often have inspiring ideas but without a grounding in how to transfer these ideas from the lab (or the garage) to the market many of these brilliant creations go unnoticed.

As EET grows, universities are working to develop effective educational strategies. Universities have examined both deductive and inductive learning techniques. With deductive learning a student applies what others know. However, with inductive learning students identify entrepreneurial issues by co-creating and interacting in a new complex environment (Kickul and Fayolle 2007). Simulations and virtual worlds are a great tool to use in creating the complex environments necessary for inductive learning. .

Virtual worlds are digital representations of the real world. Users are able to interact with others from all over the world via the internet in various environments, one of those being commerce. Effective use of virtual worlds in EET requires an understanding of the dynamics of virtual entrepreneurship. This can be achieved through studying the virtual entrepreneur. These

entrepreneurs provide goods in services within a virtual world which exists entirely in cyberspace. Given the intangible nature of the environment and sometimes fantastical settings, many doubt the validity and usefulness of investigating virtual entrepreneurship.

The Entrepreneurial Attitudes Orientation (EAO) tool can be used to assess the entrepreneurial propensity of virtual entrepreneurs and serve as a basis for comparison between virtual and conventional entrepreneurs. The EAO is one of the standard instruments used to identify entrepreneurial intentions. The attitudes of individuals are assessed in a 75 question survey across 4 subsets, achievement, innovation, personal control, and self-esteem. In initial validity testing the EAO was able to identify entrepreneurs with 77% accuracy. The original survey was administered in person with paper and pen; however in this study participants completed the survey online (Robinson, et al. 1991).

Being motivated by all of these topics, this paper intends to continue the conversation over the use of virtual worlds in EET. To determine if the underlying functioning of these worlds are similar enough to the real world, it is important to investigate who chooses to become a virtual entrepreneur. The EAO will help validate whether the entrepreneurial attitudes of virtual entrepreneurs and conventional entrepreneurs are similar. Using the replicated survey we find that entrepreneurial propensity is as strong, or stronger than the identified entrepreneurs in the original Robinson, et al (1991) study. We also find that across a number of other comparisons the virtual entrepreneur has the same entrepreneurial propensity as conventional entrepreneurs.

The rest of the paper is organized as follows; section II discuss the relevant entrepreneurship, education and virtual world literature, section III presents the survey design and implementation. Section IV presents the survey results and discussion; section V ends with concluding remarks.

Entrepreneurship Education and Training

In a report for the Kauffman Foundation, Charney & Libecap (2000) report findings from the University of Arizona's entrepreneurship program from 1985-1999. There are several key findings from this study. They find that, on average, entrepreneurship graduates were three times more likely to start a new business when compared to non-entrepreneurship graduates. Also, over time and on average, students graduating with an entrepreneurship degree were three times more likely to report themselves as self-employed than general business graduates. Other factors such as higher income, increased company sales and the promotion of technology transfers were all attributed to entrepreneurship education. Martin *et al.* (2013) conducted a meta-analysis of studies from a wide variety of business and management research databases along with other solicited writings on the subject of EET. They found that EET is positively related to the accumulation of human capital, as measured by entrepreneurship-related human capital assets, entrepreneurship-related knowledge and positive perception of entrepreneurship. The findings suggest that EET is also positively associated with entrepreneurship outcomes, start-ups and entrepreneurship performance. This suggest that not only does entrepreneurship education build valuable human capital but that this translates to measurable increases in the probability of participation in entrepreneurial ventures and an increase in the likelihood of success in these ventures.

Demand for EET programs has been growing for at least the last ten year. These new EET programs are most often found in management departments and business schools. Finkle (2010) found that the field of entrepreneurship is becoming institutionalized by business and management schools by looking at a number of data sources. Finkle discussed how the growth in hiring of entrepreneurship faculty and the rise of entrepreneurship centers offer support for the

high-growth of this field of education. In the hiring season for the 2007/2008 academic year, there were 366 open positions which was the largest number in the history of the field.

Interestingly enough, there were only 231 candidates listing entrepreneurship as one of his or her specialties. This increase in EET programs has motivated investigation into effective EET strategies and techniques.

It is suggested that EET could be improved by focusing on a learning perspective as opposed to a teaching perspective (Kickul and Fayolle 2007). The teaching perspective is input oriented and is heavily reliant on the faculty's expertise. On the other hand, a learning perspective is output oriented and there is a heavy reliance on the student. Kickul & Foyolle (2007) encourage interdisciplinary approaches to EET. This could include engineering, computer science, psychology, business and economics courses.

EET entails the use of extra resources when compared to other majors or specialties. Often times, the final project for an entrepreneurship course is to develop a business plan. This requires a large time investment from the student in comparison to other final projects and course requirements. Instructors have to be available to assist students as they work through the inevitable hurdles in developing a good business plan in only a couple of months. EET often uses online tools and simulations to offer students extra practice in participating in business plan development and the management and fund raising for a start-up firm. Many universities with an entrepreneurship specialty or major create an entrepreneurship center and possibly a university affiliated business incubator or hotel. The establishment of these centers, incubators, and hotels necessarily involve a significant investment of resources. Exploration into virtual worlds and virtual entrepreneurs may provide a more cost effective way to improve EET.

Virtual Worlds and Second Life

A virtual world can be defined as an internet based environment that is characterized by persistence, interactivity and physicality (Castronova 2001). This means individuals accessing the virtual world can interact with others in an environment that approximates the physical laws of earth, where their actions have a lasting effect on the environment. Interaction within the virtual world occurs through an avatar, or digital representation of the user.

The first virtual worlds created were designed as video games where users needed to work together to achieve specific goals. Later a more social variety of virtual world was created. In these virtual worlds users were not given specific goals, rather they were encouraged to interact with others and create new virtual item and experiences within the virtual world. These virtual worlds became known as social virtual worlds. The largest social virtual world is Second Life (SL).

SL was developed by Linden Labs and opened in 2003. Since opening SL over 36 million accounts have been created (Gray 2013). Users in SL are able to create market and sell virtual items. These items exist entirely within SL and are created using a scripting language, known as Linden Scripting Language. This programming language allows users to create items and alter (within limits) the virtual world around them. SL is unusual among virtual worlds, in that users have full ownership of their creations within SL. The users purchase the created goods and services with a digital currency, known as Linden Dollars. US Dollars can be purchased with Linden Dollars through a variable exchange rate market know as, LindeX (Linden Research, Inc. 2014).

The monetary connection between Second Life and the real world, as well as the ownership of property has encouraged many entrepreneurs to start businesses in Second Life.

The most popular industry creates and markets clothing and hairstyles for avatars. Beyond the avatar fashion industry, entrepreneurs in SL have entered into the entertainment industry by creating night clubs, as well as the real estate industry by creating and selling virtual property. By 2013 over \$3.2 billion dollars in transaction occurred (Gray 2013).

The Use of Simulations and Virtual Worlds in Higher Education

Virtual worlds are environments which stimulate creativity and encourage collaborative teamwork (Alahuhta, et al. 2014). Baker *et al.* (2009) suggest that virtual worlds, specifically, Second Life, has an abundance of uses in teaching. They recommend instructors use Second Life as a place to meet with students, create labs and other objects which can be used in learning. There may be an increase in initial time investment but as instructors build these virtual environments from simple to more complex the potential benefits, such as increase in student engagement, could eventually overtake the opportunity costs of the large investment of time and technology issues. Many major universities already rent or own virtual property in the virtual world including Princeton, the University of North Carolina, the University of Kentucky and Bowling Green State University (Baker, Wentz and Woods 2009).

Entrepreneurship and the Virtual Entrepreneur

While on the surface the virtual entrepreneur mirrors the conventional entrepreneur, there are some key differences. The first and most obvious difference is the ease of business creation. A noted example is Anshe Chung, who became the first virtual entrepreneur millionaire with an initial investment of less than \$10 (Chung 2006). Starting a business in the real world is a much more intensive process and requires a much higher initial investments. By lowering the barriers to entry SL may allow people who have only a mild entrepreneurial propensity to start business, when they would not in conventional circumstances.

Chandra and Leenders (2012) also highlighted an unusual characteristic in their study of innovation and entrepreneurship in the virtual world. The authors found that the four entrepreneurs they studied all had reported having accidentally discovered their entrepreneurial opportunities and were not looking for a profit when they entered SL. This stands in contrast to conventional entrepreneurs who require a much more significant investment. This also indicates that conventional entrepreneurs may be more committed entrepreneurs with stronger entrepreneurial propensity. If this is true then virtual worlds would not be an effective tool for EET.

Survey Mechanism

The EAO is a 75 question survey that identifies entrepreneurial propensity using attitude theory. The attitudes of individuals are assessed across 4 subsets, achievement in business, innovation in business, perceived personal control of business outcomes, and perceived self-esteem in business. Robinson, et al. (1991) define the four subsets as,

1. *Achievement in business*, referring to concrete results associated with the start-up and growth of a business venture.
2. *Innovation in business*, relating to perceiving and acting upon business activities in new and unique ways
3. *Perceived personal control of business outcomes*, concerning the individual's perception of control and influence over his or her business.
4. *Perceived self-esteem in business*, pertaining to the self-confidence and perceived competency of an individual in conjunction with his or her business affairs.

In their original experiment Robinson, et al administered the survey to 54 conventional entrepreneurs and 57 non-entrepreneurs. The authors used a univariate F test for the each subset

and for the sum of subsets. For all 5 tests the entrepreneurs were found to have significantly higher scores. The results demonstrated 77% accuracy in predicting entrepreneurs versus non-entrepreneurs (Robinson, et al. 1991).

Since its introduction the EAO has been used to identify entrepreneurial propensity, and as a yard stick for competing surveys (Draghici and Albulescu 2014); (Harris, et al. 2011); (Krueger, Jr., Reilly and Carsrud 2000). Harris and Gibson (2008) used the EAO to evaluate the entrepreneurial attitudes of US business students. The authors found that the majority of business students surveyed did have strong entrepreneurial attitudes and no significant difference in entrepreneurial attitudes based on race or major within a business program. Additionally the authors found that previous experience at a small business did not increase entrepreneurial propensity, though having owned a small business and having a small business in one's family were both correlated with stronger entrepreneurial attitudes (Harris and Gibson 2008).

Pellissier and Van Buer (1996) used the EAO to identify entrepreneurial propensity in a study examining interpretation of subjective probability. Subjects in the study were asked to provide a numeric probability for a series of subjective probability phrases (e.g. "very high chance," "possible," etc.) in addition to the EAO questions. The authors found there was no significant difference in reported probabilities between the entrepreneurial and non-entrepreneurial subjects. The authors were also able to confirm the validity of the EAO survey, since there were a number of actual entrepreneurs among the subjects. In a related study of risk and probability, Barber III (2014) used a subset of the EAO questions in an economic experiment to compare the risk preferences of entrepreneurs and non-entrepreneurs in the U.S. and Brazil. Barber III found no significant differences between the responses of Brazilian and American participants, no significant differences between genders, age or marital status. However, the

author did find mixed support for a difference in risk preferences between entrepreneurial and non-entrepreneurial participants.

Methodology

This study replicates Robinson, et al.'s (1991) original paper online using a browser based survey tool, to ask the same 75¹ questions of virtual entrepreneurs and non-entrepreneurs from Second Life. The study was approved by the IRB at Edinboro University of Pennsylvania. Participants were recruited through in-world communication, through classified advertisement within SL, and through posts on forums related to SL and entrepreneurship. Participants were directed to an associated web link that took them to the survey. Participants received approximately the same instructions used in Robinson, et al. (1991); though the instructions appeared as text instead of vocal instruction.

Indicate how much you agree with each of the following statements by *selecting* a number between “1” and “10” where “1” indicates that you strongly disagree with the statement and “10” indicates you strongly agree with the statement. A “5” indicates you only slightly disagree and a “6” shows only slight agreement. Work as quickly as you can, don't stop to think too deeply about any one question, but *select* your first thought. Please answer all the questions².

In addition to the 75 EAO questions, respondents were asked some demographic questions, and questions to identify as virtual and/or conventional entrepreneurs and non-entrepreneurs. To determine if a subject was considered a virtual entrepreneur, the following questions were asked: Did you start a Business in Second Life? If yes, how many businesses have you started in Second Life? How much income did you earn from your Second Life businesses over the past 12 months?

¹ A full list of the EAO questions is in the Appendix.

² The italicized words were changed to reflect the online nature of the survey. Selecting replaced circling, and select replaced mark.

Results and Discussion

19 SL entrepreneurs and 4 non-entrepreneurs were surveyed in the fall of 2014. The EAO and entrepreneurial activity questions enabled the comparison of virtual and conventional entrepreneurs. The responses show virtual entrepreneurs had EAO scores as least as high as the conventional entrepreneurs from the original Robinson, et al (1991) study.

The variance in respondents' age was high. The respondents are evenly split between genders. More than one-third of respondents are also entrepreneurs outside of SL. More than 65% of respondents have started more than one firm, and more than half of the respondents have earned more than \$2000 from their firms. Descriptive statistics for the non-EAO characteristics are provided in Table 1.

TABLE 1: DESCRIPTIVE STATISTICS

| Variable | Count | Percent | | Count | Percent |
|---------------------------------|-------|---------|------------------------------------|-------|---------|
| Gender | | | Number of SL firms started | | |
| Male | 11 | 52.38% | 0 | 2 | 8.70% |
| Female | 10 | 47.62% | 1 | 6 | 26.09% |
| | | | 2 | 8 | 34.78% |
| Marital Status | | | 3 | 4 | 17.39% |
| Never Married | 12 | 52.17% | 4 | 1 | 4.35% |
| Married | 6 | 26.09% | 5 | 2 | 8.70% |
| Divorced | 4 | 17.39% | | | |
| Other | 1 | 4.35% | Income earned from SL firms | | |
| | | | Less than\$10 | 3 | 14.29% |
| Started a SL firm | | | \$10-\$49 | 1 | 4.76% |
| Yes | 19 | 82.61% | \$50-\$99 | 1 | 4.76% |
| No | 4 | 17.39% | \$100-\$199 | 1 | 4.76% |
| | | | \$200-\$499 | 2 | 9.52% |
| Started a real life firm | | | \$500-\$999 | 0 | 0% |
| Yes | 9 | 36.13% | \$1000-\$1999 | 2 | 9.52% |
| No | 14 | 60.87% | \$2000 or greater | 11 | 52.38% |
| | Count | Mean | Std Dev | Min | Max |
| Age | 22 | 42.86 | 17.04 | 22 | 85 |

Table 1: Descriptive statistics for demographic and entrepreneurial activity responses.

EAO scores and sub-scores were computed for all 19 entrepreneurs. T-tests comparing the scores of SL entrepreneurs and from Robinson, et al (1991) were conducted. The null hypothesis of equality between the two scores fails to be rejected, for the Overall score as well as the Self-Esteem, Personal Control and Innovation sub-scores. One-sided t-tests reveal that respondent's Achievement scores are greater than the Robinson, et al (1991) scores. The scores, t-test results are presented in Table 2.

TABLE 2: EAO SCORES AND SIGNIFICANCE TESTING

| Category | Entrepreneurial Status | Mean (Std. Dev.) | Robinson, et al Mean | t-value | p-value |
|-------------------------|------------------------|------------------|----------------------|---------|---------|
| Overall | | | | | |
| | Non-Entrepreneur | 6.47 (1.44) | 5.82 | 0.78 | 0.45 |
| | Entrepreneur | 7.04 (0.84) | 6.89 | | |
| Achievement | | | | | |
| | Non-Entrepreneur | 7.35 (1.28) | 6.46 | 1.88 | 0.08 |
| | Entrepreneur | 7.80 (1.20) | 7.28 | | |
| Self-Esteem | | | | | |
| | Non-Entrepreneur | 6.08 (1.54) | 6.27 | -1.75 | 0.10 |
| | Entrepreneur | 6.68 (0.94) | 7.10 | | |
| Personal Control | | | | | |
| | Non-Entrepreneur | 5.84 (1.85) | 5.24 | 1.26 | 0.22 |
| | Entrepreneur | 6.85 (0.93) | 6.58 | | |
| Innovation | | | | | |
| | Non-Entrepreneur | 5.84 (1.85) | 5.29 | 1.34 | 0.20 |
| | Entrepreneur | 6.85 (0.93) | 6.64 | | |

Table 2: Entrepreneur and non-entrepreneur EAO scores in column 3. Standard deviations are reported below in parentheses. Column 4 reports mean EAO scores for entrepreneurs from Robinson, et al (1991). Columns 5 and 6 report t and p values.

Given the large number of real world entrepreneurs, it could be that the high EAO scores were driven by the real world entrepreneurs. Real world entrepreneurs would be expected to report EAO scores on par with the entrepreneurs from Robinson, et al (1991). Among SL

entrepreneurs the EAO scores were tested for any significant difference between real world and SL entrepreneurs, and exclusively SL entrepreneurs. T-tests show no significant difference between the respondent scores of real world entrepreneurs and SL entrepreneurs. Means, t-values, and p-values are reported in table 3.

TABLE 3: SECOND LIFE ENTREPRENEURS

| Score | Group Means | | t-value | p-value |
|-------------------------|-------------|-------------|---------|---------|
| | RW Start | No RW start | | |
| Overall | 7.27 | 6.87 | -1.03 | 0.32 |
| Achievement | 8.04 | 7.62 | -0.74 | 0.47 |
| Self-Esteem | 7.02 | 6.43 | -1.40 | 0.18 |
| Personal Control | 7.16 | 6.63 | -1.25 | 0.23 |
| Innovation | 7.04 | 6.81 | -0.56 | 0.58 |

Table 3 Mean EAO scores separated by real world firm starts are reported in columns 2 and 3. Column 4 and 5 report t and p values for two sided t-test between group means.

It is also worth noting that t-tests report no significant difference between genders. This is consistent with earlier studies such as Barber III (2014). These results can be seen in table 4.

TABLE 4: EAO SCORES BY GENDER

| Score | Group Means | | t-value | p-value |
|-------------------------|-------------|--------|---------|---------|
| | Male | Female | | |
| Overall | 7.31 | 7.01 | 0.86 | 0.41 |
| Achievement | 7.92 | 8.0 | -0.14 | 0.89 |
| Self-Esteem | 6.92 | 6.59 | 0.69 | 0.50 |
| Personal Control | 7.23 | 6.74 | 1.15 | 0.27 |
| Innovation | 7.31 | 6.74 | 1.58 | 0.14 |

Table 4: Mean EAO scores separated by gender are reported in columns 2 and 3. Column 4 and 5 report t and p values for two sided t-test between group means.

The results from tables 2, 3 and 4 indicate there are no major differences between virtual and conventional entrepreneurs. This would suggest that entrepreneurial skills and propensity developed in the virtual world could easily be transferred into the real world.

Conclusion

The use of simulations and technologies are on the rise in the classroom. These types of technologies and virtual environments are especially useful in EET programs. Some of the mechanics of being an entrepreneurs can be taught e.g. writing a business plan, methods to search for funding, how to prepare financial statements, etc. However, the true entrepreneurial spirit which will drive success lies within the individual.

There are mixed results around the success of traditional EET programs. Fayolle and Gailly (2015) finds that entrepreneurship education programs have differing effects on entrepreneurial intentions. More specifically, the results are strongly related to previous exposure to entrepreneurial ventures and suggest that the more previous involvement in entrepreneurial ventures the *less* effective the education programs were.

As these types of results are found, it is important to take a closer look at the design of entrepreneurship education programs. Our results suggest that virtual life entrepreneurs' EAO scores were on par with the conventional entrepreneurs from the original Robinson et al (1991) study. For the Achievement sub-score virtual entrepreneurs' scores were even higher than the conventional; indicating stronger entrepreneurial attitudes in this sub-section. This leads to the need for further investigation of the differences between those who are virtual and conventional entrepreneurs.

The results affirm the assertion that virtual entrepreneurs are a subset of conventional entrepreneurship. This is encouraging for entrepreneurship education. If these virtual environments are attractive for entrepreneurial individuals to participate in then they may translate well for the use of these environments in classroom. Experiential learning is vital to entrepreneurial success. SL offers students and educators a low-cost realistic entrepreneurial

environment. In this inductive learning environment students have to opportunity to develop risk-taking, decision-making, time management and planning skills.

Future research should focus on the effective implementation of EET techniques within the virtual world. These techniques will need to provide students effective learning opportunities; while preserving and strengthening the entrepreneur-friendly environment within SL.

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APPENDIX

Entrepreneurial Attitudes Orientation (EAO)

“Indicate how much you agree with each of the following statement by selecting a number between “1” and “10” where “1” indicates that you strongly disagree with the statement and “10” indicates you strongly agree with the statement. A “5” indicates you only slightly disagree and a “6” shows only slight agreement. Work as quickly as you can, don’t stop to think too deeply about any one question, but mark down your first thought. Please answer all the questions.

1. I get my biggest thrills when my work is among the best there is. (achievement – affect)
2. I seldom follow instructions unless the task I am working on is too complex. (innovation – behavior)
3. I never put important matters off until a more convenient time. (achievement – behavior)
4. I have always worked hard in order to be among the best in my field. (personal control – behavior)
5. I feel like a total failure when my business plans don’t turn out the way I think they should. (self-esteem – affect)*
6. I feel very energetic working with innovative colleagues in a dynamic business climate. (innovation – affect)
7. I believed that concrete results are necessary in order to judge business success. (achievement – cognition)
8. I create the business opportunities I take advantage of. (personal control – behavior)
9. I spend a considerable amount of time making any organization I belong to function better (achievement – behavior)
10. I know that social and economic conditions will not affect my success in business. (personal control – cognition)
11. I believe it is important to analyze your own weaknesses in business dealings. (achievement – cognition)
12. I usually perform very well on my part of any business project I am involved with. (self-esteem – behavior)
13. I get excited when I am able to approach tasks in unusual ways. (innovation – affect)
14. I feel very self-conscious when making business proposals. (self-esteem – affect)*
15. I believe that in the business world the work of competent people will always be recognized. (personal control – cognition)
16. I believe successful people handle themselves well at business gatherings. (self-esteem – cognition)
17. I enjoy being able to use old business concepts in new ways. (innovation – affect)
18. I seem to spend a lot of time looking for someone who can tell me how to solve all my business problems. (self-esteem – behavior)*
19. I feel terribly restricted being tied down to tightly organized business activities, even when I am in control. (innovation – affect)
20. I often sacrifice personal comfort in order to take advantage of business opportunities. (achievement – behavior)
21. I feel self-conscious when I am with very successful business people. (self-esteem – affect)*

22. I believe that to succeed in business it is important to get along with the people you work with. (self-esteem – cognition)
23. I do every job as thoroughly as possible. (achievement – behavior)
24. To be successful I believe it is important to use your time wisely. (achievement – cognition)
25. I believe that the authority I have in business is due mainly to my expertise in certain areas. (self-esteem – cognition)
26. I believe that to be successful a businessman must spend time planning the future of his business. (achievement – cognition)
27. I make a conscientious effort to get the most out of my business resources. (achievement – behavior)
28. I feel uncomfortable when I'm unsure of what my business associates think of me. (self-esteem – affect)*
29. I often put on a show to impress the people I work with. (self-esteem – behavior)*
30. I believe that one key to success in business is to not procrastinate. (achievement – cognition)
31. I get a sense of pride when I do a good job on my business projects. (achievement – affect)
32. I believe that organizations which don't experience radical changes now and then tend to get stuck in a rut. (innovation – cognition)
33. I feel inferior to most people I work with. (self-esteem – affect)*
34. I think that to succeed in business these days you must eliminate inefficiencies. (achievement – cognition)
35. I feel proud when I look at the results I have achieved in my business activities. (achievement – cognition)
36. I feel resentful when I get bossed around at work. (personal control – affect)
37. Even though I spend some time trying to influence business events around me every day, I have had very little success. (personal control- behavior)*
38. I feel best about my work when I know I have followed accepted procedures. (innovation – behavior)*
39. Most of my time is spent working on several business ideas at the same time. (innovation – behavior)
40. I believe it is more important to think about future possibilities than past accomplishments. (achievement – cognition)
41. I believe that in order to succeed, one must conform to accepted business practices. (innovation - cognition)*
42. I believe that any organization can become more effective by employing competent people. (personal control – cognition)
43. I usually delegate routine tasks after only a short period of time. (innovation – behavior)
44. I will spend a considerable amount of time analyzing my future business needs before I allocate any resources.(achievement – behavior)
45. I feel very good because I am ultimately responsible for my own business success. (personal control – affect)
46. I believe that to become successful in business you must spend some time every day developing new opportunities. (innovation – cognition)
47. I get excited creating my own business opportunities. (personal control – affect)

48. I make it a point to do something significant and meaningful at work every day. (achievement – behavior)
 49. I usually take control in unstructured situations. (innovation – behavior)
 50. I never persist very long on a difficult job before giving up. (self-esteem – behavior)*
 51. I spend a lot of time planning my business activities. (personal control – behavior)
 52. I believe that to arrive at a good solution to a business problem, it is important to question the assumption made in defining the problem. (innovation – cognition)
 53. I often feel badly about the quality of work I do. (self-esteem – affect)
 54. I believe it is important to continually look for new ways to do things in business. (innovation – cognition)
 55. I believe it is important to make a good first impression. (self-esteem – cognition)
 56. I believe that when pursuing business goals or objectives, the final result is far more important than following the accepted procedures. (innovation – cognition)
 57. I feel depressed when I don't accomplish any meaningful work. (achievement – affect)
 58. I often approach business tasks in unique ways. (innovation – behavior)
 59. I believe the most important thing in selecting business associates is their competency. (achievement – cognition)
 60. I take an active part in community affairs so that I can influence events that affect my business. (personal control – behavior)
 61. I feel good when I have worked hard to improve my business. (achievement – affect)
 62. I enjoy finding good solutions for problems that nobody has looked at yet. (innovation – affect)
 63. I believe that to be successful a company must use business practices that may seem unusual at first glance. (innovation – cognition)
 64. My knack for dealing with people has enabled me to create many of my business opportunities. (personal control – behavior)
 65. I get a sense of accomplishment from the pursuit of my business opportunities. (achievement – affect)
 66. I believe that currently accepted regulations were established for a good reason. (innovation – cognition)*
 67. I always feel good when I make the organizations I belong to function better. (achievement – affect)
 68. I get real excited when I think of new ideas to stimulate my business. (innovation – affect)
 69. I believe it is important to approach business opportunities in unique ways. (innovation – affect)
 70. I always try to make friends with people who may be useful in my business. (achievement – behavior)
 71. I usually seek out colleagues who are excited about exploring new ways of doing things. (innovation – behavior)
 72. I enjoy being the catalyst for change in business affairs. (innovation – affect)
 73. I always follow accepted business practices in the dealings I have with others. (innovation – behavior)*
 74. I rarely question the value of established procedures. (innovation – behavior)*
 75. I get a thrill out of doing new, unusual things in my business affairs. (innovation – affect)
- * indicates reverse scored.

Relationships among Diversity, Communication and Verbal Miscommunication in Culturally Diverse Work Groups

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ABSTRACT

This study sought to fill the gap in the literature on the relationships among diversity, communication and verbal miscommunication in culturally diverse work groups to discern the salient antecedents of verbal miscommunication in these work. Data were collected from individuals employed at culturally diverse organizations across the U.S. Exploratory factor analysis and multiple regression analysis were used to test hypotheses. Study findings identified the most salient antecedents of miscommunication in culturally diverse work groups: Societal-level cultural values, individual level cultural values, and communication openness.

Keywords: Diversity, Communication, Verbal Miscommunication, Culturally Diverse Work Groups, Cultural Values

INTRODUCTION

Work groups have become indispensable organizational units in the United States and around the globe. Most of the time, members of work groups come from different cultural backgrounds and countries. Interaction of multiple cultures brings the need for intercultural understanding and effective communication (Marga, 2010). Although culturally diverse work groups and teams have become vitally important to the success of an organization (Govindarajan & Gupta, 2001; Nohria & Garcia-Pont, 1991), their complex work processes and interactions are quite difficult to manage (Aritz & Walker, 2010). Misunderstanding is quite common in modern organizations and is considered a major source of problems among members of work teams and organizations (Casse and Weisz, 2014).

The purpose of this study is to empirically investigate the relationships among diversity, communication and verbal miscommunication in culturally diverse work groups to discern the salient antecedents of miscommunication in these work groups. Although quite a few studies have investigated the linguistic causes of misunderstanding in organizations (Blakemore, 1989; Fraser, 1993; Milroy, 1984; Scheu-Lottgen & Hernandez-Campoy, 1998; Weigand, 1999), there is a need to examine the antecedents of miscommunication using the framework of organizational behavior theories.

LITERATURE REVIEW

Background of the Problem

The topic of communication in groups has been the main focus of research on interpersonal interaction (Brannick, Roach, & Salas, 1993). Early research finds that teams had difficulties with developing the best communication system for their interaction (Marschak, 1955). Bouncken (2004) finds that communication is critically important in the culturally diverse team performance. Communication can be viewed as the use of a culturally-based code in a cultural framework to convey culturally-shaped content (Huang, Dotterweich & Bowers, 2012; Liddicoat, 2009). Intercultural communication research highlights the embeddedness of culture in a language (Liddicoat, 2009). Huang et al. (2012) state that intercultural miscommunication is the breakdown in communication among speakers from different cultures and native speakers of different languages.

Communication is an essential part of human interaction. When a communicated message is misunderstood, either the sender or the receiver, or both may be at fault (Brewer & Holmes, 2009). Communication models have evolved through the history of social research. One of the earliest definitions of communication and communication models was developed by the Greek philosopher-teacher Aristotle (384-322 B. C.), (Mortensen, 1982). To date, all models can be divided into linear and non-linear communication models. Early linear models include the Shannon-Weaver Mathematical Model (1949), the Interactive Model developed by Weiner (1948), Berlo's S-M-C-R Model (1960), Schramm's Interactive Model (1954), and other models.

According to the survey conducted by Catt, Miller and Hindi (2005) on practices in *Fortune* 200 companies, organizations spend millions of dollars annually on communication training for their employees. These figures do not include the significantly higher costs of miscommunication because they cannot be directly calculated. To help avoid miscommunication, Catt et al. (2005) developed MISCUES, a communication "pyramid". The acronym stands for meaning, inferences, stereotyping, clarity, understanding, experience, and selective perception. Catt et al. (2005) argue that ideal interactions lead to shared meanings. However, they find that the dimensions included in the "pyramid" are the most common causes of miscommunication. Professionals in the workplace may differ in all dimensions of the communication "pyramid" which leads to miscommunication and negative group and organizational outcomes.

Study Constructs

This study examines two constructs each consisting of several variables that act as antecedents of miscommunication in culturally diverse work groups. The cultural diversity construct consists of cultural diversity, societal cultural values, individual cultural values, and cultural distance variables. The communication construct consists of perceived language proficiency, communication styles and communication openness.

For the purposes of this study, miscommunication in culturally diverse work groups is defined as failure of the sender and receiver from different cultures to communicate clearly and properly between or among themselves.

The analysis of the existing research literature reveals the two paradigms used to understand the diversity effects in teams and groups: The factor approach (Harrison, Price, Gavin, & Florey, 2002; Harrison, Price, & Bell, 1998; Jackson et al., 1995) and the proportions approach (Blau, 1977; Kanter, 1977; Mannix & Neale, 2005; Pettigrew, 1982). This study used the proportions' approach to measure cultural diversity as developed by Peter Blau (1977).

The societal cultural values are deeply engrained in the self-concepts of employees and have a strong impact on their behaviors and their individual-level cultural values (Hofstede, Hofstede, & Minkov, 2010; Schwartz, 1992). Schwartz and colleagues conducted a number of studies to validate the structure of individual-level and societal-level values models (Fischer, Vauclair, Fontaine, & Schwartz, 2010; Schwartz, 1992, 1994, 2006). Schwartz et al. (Schwartz, 1994, 1999, 2006; Fischer et al., 2010) and consistently found support for the theorized cultural values model. Societal and individual cultural values in this study were also measured using societal-level values dimensions from the Schwartz Values Survey (SVS; Schwartz 1992, 1994, 2006).

Cultural distance is defined here as a difference in cultural values between and among individuals working in a group (Simonin, 1999). Negative effects of cultural distances on collaboration, ranging from cross-cultural negotiations to joint venture performance and failures, have been reported in the literature (Mjoen & Tallman, 1997; Pariche, 1991; Simonin, 1999). Cultural distance in this study was evaluated by an instrument adapted from the two-item measure developed by Simonin (1999).

Language proficiency is quite complex as it “involves the paralinguistic cues, gestures, facial expressions, body movements and cues provided by the physical environment that accompany verbal messages” (Burgoon, Berger, & Waldron, 2000, p. 106). The high number of tasks in the comprehension process may affect language comprehension. As a result, the message is decoded not as intended by the sender thereby causing misunderstanding. A three-item instrument developed by Gee, Walsemann and Takeuchi (2010) was used to evaluate perceived language proficiency of this study's participants.

A communication style is a manner in which an individual communicates with others (Hartman & McCambridge, 2011). Individuals display a preference in choosing a communication style from four categories: analytical, driver, amiable, and expressive (Mok, 1975; Alessandra & Hunsaker, 1993; Merrill & Reid, 1999). This study used an instrument developed by Hartman and McCambridge (2011), an updated and modified version of Mok's (1975) Communication Style Survey.

Communication openness is the willingness of a group member to have open and honest communication, and to be receptive to the communication of others (Ayoko, 2007). Communicative openness in superior-subordinate relationships is essential to effective communication in organizations (Wanguri, 1996). Housel and Davis (1977) argue that the concept of communication openness is probably the most significant factor in the investigation of upward communication distortion. This study utilized the measure for the open intra-team communication of Puck et al. (2006) originating from the work of Earley and Mosakowski (2000) on transnational team functioning.

Study Hypotheses and a Proposed Study Model

The study tested the following two research hypotheses with several sub-hypotheses each. A proposed study model graphically depicts hypothesized relationships.

H1: *Cultural diversity construct is positively related to verbal miscommunication in culturally diverse work groups.*

- H1a: Cultural diversity in a work group is positively related to verbal miscommunication in culturally diverse work groups.*
- H1b: Higher diversity in societal-level cultural values is positively related to verbal miscommunication in culturally diverse work groups.*
- H1c: Higher diversity in individual-level cultural values is positively related to verbal miscommunication in culturally diverse work groups.*
- H1d: Higher cultural distances among members of a culturally diverse group are positively related to verbal miscommunication in culturally diverse work groups.*

H2: *Communication construct is positively related to verbal miscommunication in culturally diverse work groups.*

- H2a: Low perceived language proficiency in English is positively related to verbal miscommunication in culturally diverse work groups.*
- H2b: Communication style is positively related to verbal miscommunication in culturally diverse work groups.*
- H2c: Lack of communication openness is positively related to verbal miscommunication in culturally diverse work groups.*

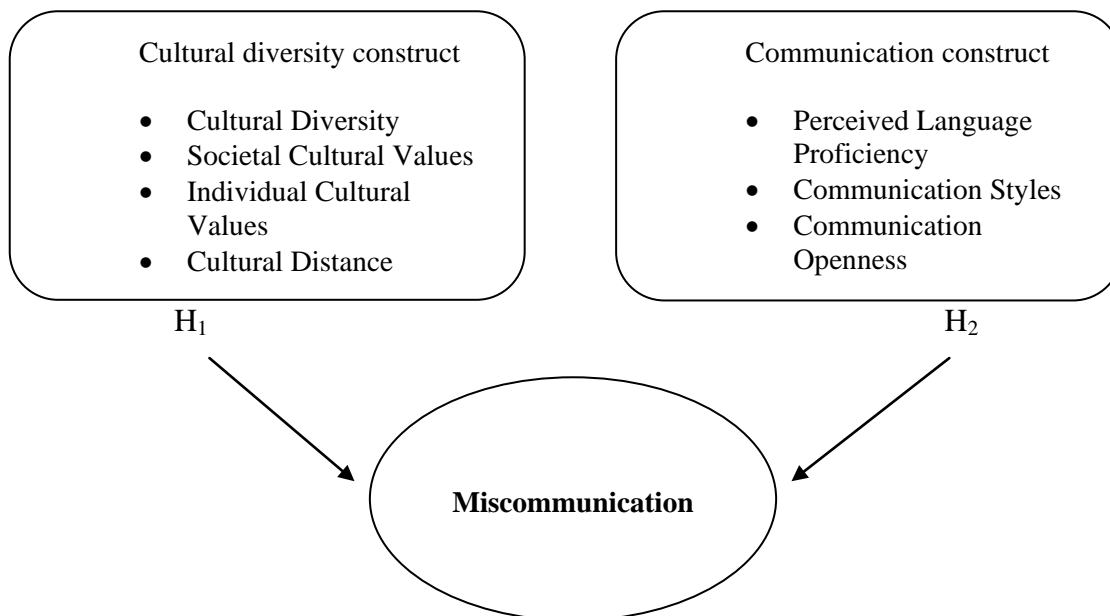


Figure 1: Theoretical Model

METHODOLOGY

Sample and Data Collection

The study sample was comprised of 222 members of culturally diverse work groups employed at diversified companies based in the U.S. The sample respondents were invited to participate voluntarily. A computerized structured questionnaire was used to gather data from respondents. A pilot study was conducted to test and refine the instrument. The study survey was then electronically delivered to 870 participants who were assured of the anonymity of their responses with a consent form. The collected data yielded a sample size of 375 and a response rate of 43.10 percent. The data was further cleaned, which yielded a final usable sample of 222 observations.

Test Statistic

Multiple regression analysis with stepwise estimation procedure was used to test the hypotheses. Miscommunication was selected as the dependent variable to be predicted by seven independent variables: Cultural Diversity, Individual Cultural Values, Societal Cultural Values, Cultural Distance, Perceived Language Proficiency, Communication Styles, and Communication Openness.

Examination of the correlation matrix revealed that the Communication Openness variable had the highest bivariate correlation with the dependent variable (.697) followed by the Societal Cultural Values (.505) and Communication Styles (.478). Multicollinearity diagnostics were performed and it was concluded that 3 out of 32 correlations were higher than .5 but still less than .7. There were no very highly correlated variables. The VIF values were less than 10. The independent variables had the desirable characteristics. Thus, all variables were retained for further analysis.

DISCUSSION OF RESULTS

Multiple regression analysis indicated that the model was found statistically significant with $F = 97.252$ and a p -value $= .000$ ($p < .05$). The adjusted R^2 was .566. Thus, 56.6% of the variance in miscommunication among culturally diverse work group members was accounted for by the variables included in the model.

Results of the multiple regression analysis revealed that only the linear combination of the Individual Cultural Values, Societal Cultural Values, and Communication Openness were significantly related to verbal miscommunication in culturally diverse work groups. Further, results indicated that the Individual Cultural Values, Societal Cultural Values, and Communication Openness variables each had a statistically significant relationship to miscommunication with a p -value $= .000$.

The results of testing sub-hypotheses demonstrated significant positive relationships for hypothesis 1b and hypothesis 1c ($\beta = .295$, $t = 4.371$, $p = .000$ and $\beta = .203$, $t = 3.543$, $p = .000$, respectively). Hypothesis 2c tested whether the lack of communication openness was positively related to miscommunication. The findings were significant ($\beta = .545$, $t = 9.531$, $p = .000$).

CONCLUSION

This study sought to address a need to empirically examine the theorized relationships and to provide managers and other practitioners with first-hand data analysis of relationships among cultural diversity, communication and verbal miscommunication in culturally diverse work groups in organizations in the United States.

Present study findings identified three most salient antecedents of miscommunication in culturally diverse work groups: Societal values, individual-level values, and communication openness. At the practical level, these findings mean that differences in societal-level and individual-level values among members of culturally diverse groups may lead to verbal miscommunication.

Communication openness was also found to be a significantly important antecedent of verbal miscommunication in culturally diverse work groups. Managers need to be aware of cultural norms that may dictate the degree of openness in communication which vary from culture to culture. Thus, managers and practitioners need to promote an awareness and understanding of cultural differences that may affect verbal communication in this type of groups.

REFERENCES

[References available upon request.]

RUN TESTS FOR A SEQUENCE OF NOMINAL DATA WITH MULTI-CLASSES: A UNIFIED APPROACH BASED ON RECURRENCE RELATIONS

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ABSTRACT

We propose various “run tests” for a sequence of nominal data with more than two classes. Specifically, we derive recursive equations and find the probability distributions of the total number of runs and the maximum run length. Based on the two types of test statistics and two different sampling methods, various run tests can be classified into four cases. Numerous researchers have derived the probability distributions in many different ways, treating each case separately. In the paper, we propose a unified approach which is based on recurrence arguments of mutually exclusive sub-sequences.

1. INTRODUCTION

In many experiments or observational studies, each element in the sample space can assume only one of two possible outcomes, such as head and tail, success and failure, or up and down. The order in which the elements of the sample were drawn is frequently available. In any ordered sequence of n elements of two kinds, a “run” is defined as a succession of similar events preceded and succeeded by different elements. The number of elements in a run is referred to as its length. We can also count the total number of runs in an ordered binary sequence.

Consider, for example, the ordered sequence of 10 binary numbers, 1 1 1 1 0 1 1 0 0 1. The total number of *runs* in the sequence is five (i.e., 1 1 1 1 0 1 1 0 0 1), among which the number of 1 runs is three and the number of 0 runs is two. The *length* of the longest 1 run is four (i.e., 1 1 1 1), whereas the *length* of the longest 0 run is two (i.e., 0 0). Thus, the *maximum run length* (i.e., the length of the longest 1 or 0 run) is four in the binary sequence.

Various types of *run tests* have been proposed to examine whether or not a binary sequence is randomly generated. If the number of runs is too high or too low, we may suspect the statistical independence of each trial or the randomness of the arrangements. Likewise, the maximum run length in a binary sequence can be also used to test the randomness of the sequence.

In the paper, we derive the exact probability distributions of (i) the number of runs and (ii) the maximum run length for a sequence of the categorical variable with *more than two* classes. Probability distributions are expressed as recursive equations, and can be easily implemented with spreadsheet software such as Microsoft Excel. It can be easily shown that each of the traditional run tests for a binary sequence is a special case of our run tests in which there are only two classes. We also show that our run tests can be applied to several areas in quality control, such as testing changes in process variation, developing multivariate control charts, and comparing the shapes location and the shape of more than two populations.

In the next section, we classify various run tests into four different cases and define some notation that will be used throughout the paper.

2. CLASSIFICATION OF RUN TESTS

An ordered sequence of n elements of m different types can be generated by two different sampling methods [2]. First, in *multinomial* sampling, on one hand, each element is obtained from an infinite population with a known probability set $\mathbf{p} = \{p_1, p_2, \dots, p_m\}$, where $p_1+p_2+\dots+p_m = 1$ and m is the number of distinct classes (e.g., win, lose, and draw in a series of chess games). As in the Bernoulli scheme, each trial is considered an independent, identically distributed random variable that may take on one of the m possible values, with the outcome j occurring with constant probability p_j . For an ordered sequence of size n , the total number of possible permutation with m distinct classes is m^n .

Second, in *hypergeometric* sampling, each element is taken from a finite population with given numbers of elements $\mathbf{d} = \{d_1, d_2, \dots, d_m\}$, where $n = d_1+d_2+\dots+d_m$ and m is the number of distinct classes (e.g., arrange 2 teachers, 3 parents, and 4 students in a row for a school picture). From the finite population, we randomly select one element at a time without replacement and arrange them in chronological order. In such a case, the total number of distinguishable orderings is $n!/(d_1!d_2!\dots d_m!)$, and we assume that each of the distinct arrangements is equally likely.

As in the formulation of a dynamic programming problem, we define the *stage* and the *state* as follows: We are said to be at the i th stage ($i=1, 2, \dots, n$) when we obtain the i th outcome in multinomial sampling or draw the i th element in hypergeometric sampling. The state j at stage i is the result of the i th outcome or the type of the i th element. The state at each stage is simply represented as an integer number j , where $j=1, 2, \dots, m$. Of course, all the m states are mutually exclusive.

As stated in [1], “the two most commonly used statistics for testing of randomness are the total number of runs and the length of longest run.” To test the randomness of an ordered sequence at a given level of significance, we consider those two types of test statistics in the paper. Let z denote the *total number of runs* and let r be the *maximum run length* in a sequence of size n . The sequence is generated by the multinomial sampling with n and $\mathbf{p}=\{p_1, p_2, \dots, p_m\}$ or by the hypergeometric sampling with $\mathbf{d}=\{d_1, d_2, \dots, d_m\}$. Based on the types of the test statistic and the sampling method, a run test can be classified into one of the four different cases in Table 1.

Table 1. Classification of run tests.

| | Multinomial sampling with n and $\mathbf{p}=\{p_1, p_2, \dots, p_m\}$ | Hypergeometric sampling with $\mathbf{d}=\{d_1, d_2, \dots, d_m\}$ |
|-------------------------|--|---|
| Number of runs, z | ▪ Case 1. $\pi_z^j(n, \mathbf{p})$ | ▪ Case 3. $\pi_z^j(\mathbf{d})$ |
| Maximum run length, r | ▪ Case 2. $\rho_r^j(n, \mathbf{p})$ | ▪ Case 4. $\rho_r^j(\mathbf{d})$ |

In Table 1, π_z^j in Cases 1 and 3 denotes the probability that the number of runs in the sequence is exactly z when the state at stage n is j (i.e., the last element in the ordered sequence of size n is of type j). Because m sub-sequences are mutually exclusive, the probability π_z^* that the total number of runs is z is simply

$$\pi_z^* = \sum_{j=1}^m \pi_z^j. \tag{1}$$

Similarly, ρ_r^j in Cases 2 and 4 represents the probability that the maximum run length in the

sequence is *at least* r when the state at stage n is j , where $j=1, 2, \dots, m$. Therefore, the probability that the maximum run length is at least r in a sequence of multi-state trials is

$$\rho_r^* = \sum_{j=1}^m \rho_r^j. \quad (2)$$

Note that the probability that the maximum run length at stage n is exactly r is simply $\rho_r^* - \rho_{r+1}^*$. Since the early 20th century, many researchers have derived the probability distributions for each of the four cases with different methods, treating each case separately. As far as we are aware, no researchers have proposed a unified approach that deals with all the four cases in the same manner. In the paper, we propose a recursive formula for each case, all of which are based on the same simple idea that any ordered sequence can be divided into m mutually exclusive subsequences. For various \mathbf{p} and \mathbf{d} , we programmed the recursive equations in Fortran 90 and cross-checked the frequency distributions with Microsoft Excel.

3. MULTINOMIAL SAMPLING

3.1. Case 1: Number of runs

In multinomial sampling with n and \mathbf{p} , let $\pi_z^j(n, \mathbf{p})$ be the probability that the total number of runs is z when the state is j at the last stage n . Such an event can be achieved in two different ways. First, the number of runs is already z when the state is j at the previous stage $n-1$. Adding another element of the *same* type j does not change the number of runs z . Second, the number of runs is $z-1$ when the state is anything but j at stage $n-1$. In such a case, adding an element of different type j increases the number of runs from $z-1$ to z .

Thus, we have the following recurrence relations:

$$\pi_z^j(n, \mathbf{p}) = p_j \pi_z^j(n-1, \mathbf{p}) + p_j \sum_{\forall k, k \neq j} \pi_{z-1}^k(n-1, \mathbf{p}), \quad \text{for } z \geq 2 \text{ and } j=1, 2, \dots, m. \quad (3)$$

The recursive equations can be easily implemented with Microsoft Excel with $m+1$ worksheets. For spreadsheet implementation, it is more convenient to use the following recurrence relations:

$$\pi_z^j(n, \mathbf{p}) = p_j [\pi_z^j(n-1, \mathbf{p}) - \pi_{z-1}^j(n-1, \mathbf{p}) + \pi_{z-1}^*(n-1, \mathbf{p})], \quad \text{for } j=1, 2, \dots, m. \quad (4)$$

The probability that all the elements in the sequence of size n are of type j or, in other words, the number of runs is 1 is p_j^n . Thus, the boundary condition for the recursive equation is

$$\pi_z^j(n, \mathbf{p}) = \begin{cases} p_j^n & \text{if } z = 1 \\ 0 & \text{if } z \geq n. \end{cases} \quad (5)$$

Using Microsoft Excel spreadsheet, we can easily obtain the frequency distribution of the number of runs z in the multinomial sequence.

3.2. Case 2: Maximum run length

In multinomial sampling with n and \mathbf{p} , let $\rho_r^j(n, \mathbf{p})$ be the probability that the maximum run length is at least r when the state is j at the last stage n . There are two cases in which the maximum run length is at least r when the state is j at stage n . First, the maximum run length is

at least r at the previous stage $n-1$, and the state at the current stage n is simply j . Second, the maximum run length at stage $n-r$ is less than r , and the state at stage $n-r$ is anything but j . In such a case, the maximum run length becomes r if the states at the last r stages are all j .

Thus, the recurrence relation is

$$\rho_r^j(n, \mathbf{p}) = p_j \rho_r^*(n-1, \mathbf{p}) + \left((1-p_j) - \sum_{\forall k, k \neq j} \rho_r^k(n-r, \mathbf{p}) \right) p_j^r, \quad \text{for } j=1, 2, \dots, m. \quad (6)$$

To implement a spreadsheet program such as Microsoft Excel, it is more convenient to use the following expression:

$$\rho_r^j(n, \mathbf{p}) = p_j \rho_r^*(n-1, \mathbf{p}) + [(1-p_j) - \rho_r^*(n-r, \mathbf{p}) + \rho_r^j(n-r, \mathbf{p})] p_j^r. \quad (7)$$

The boundary condition for the recursive equation is

$$\rho_r^j(n, \mathbf{p}) = \begin{cases} p_j^n & \text{if } r = n \\ 0 & \text{if } r > n. \end{cases} \quad (8)$$

4. HYPERGEOMETRIC SAMPLING

4.1. Case 3: Number of runs

In hypergeometric sampling with $\mathbf{d}=\{d_1, d_2, \dots, d_m\}$, let $\pi_z^j(\mathbf{d})$ be the probability that the total number of runs is z when the state is j at the last stage $n = d_1+d_2+\dots+d_m$. For notational convenience, let $\pi_z^j(d_k - 1)$ denote the probability that the total number of runs is z when the latest state is j and only the number of elements of type k is reduced by 1; i.e., $\mathbf{d}=\{d_1, d_2, \dots, d_k - 1, \dots, d_m\}$.

When the state at the last stage n is j , the total number of runs will be z in two different cases. First, the state is j at the previous stage $n-1$ and the number of runs is already z . Adding another element of the same type j at the current stage n does not change the number of runs z . Second, the number of runs is $z-1$ when the state is anything but j at the previous stage $n-1$. In such a case, adding an element of type j increases the number of runs from $z-1$ to z at the current stage n .

Thus, we have the following recurrence relation:

$$\pi_z^j(\mathbf{d}) = \frac{d_j}{n} \pi_z^j(d_j - 1) + \frac{d_j}{n} \sum_{\forall k, k \neq j} \pi_{z-1}^k(d_k - 1), \quad \text{for } j=1, 2, \dots, m. \quad (9)$$

For a spreadsheet program, we may simply use the following recursive equation:

$$\pi_z^j(\mathbf{d}) = \frac{d_j}{n} \left[\pi_z^j(d_j - 1) - \pi_{z-1}^j(d_j - 1) + \pi_{z-1}^*(d_j - 1) \right], \quad \text{for } j=1, 2, \dots, m. \quad (10)$$

The number of runs is 1 if all the elements in the sequence of size n are of the same type j . Thus, the boundary condition is

$$\pi_r^j(\mathbf{d}) = \begin{cases} 1 & \text{if } d_j = n \\ 0 & \text{otherwise.} \end{cases} \quad (11)$$

4.2. Case 4: Maximum run length

As in the multinomial sampling, let $\rho_r^j(\mathbf{d})$ be the probability that the maximum run length is at least r when the state is j at the last stage $n = d_1 + d_2 + \dots + d_m$. As in Case 2, there are two ways in which the maximum run length is at least r when the state is j at stage n .

First, the maximum run length is at least r at the previous stage $n-1$, and the state at the current stage n is simply j . Second, the maximum run length at stage $n-r$ is less than r , and the state at stage $n-r$ is anything but j . However, the states at the next r stages are all j consecutively.

Thus, the recurrence relation for the maximum run length r is

$$\rho_r^j(\mathbf{d}) = \frac{d_j}{n} \rho_r^*(d_j - 1) + \left[\frac{n - d_j}{n - r} - \sum_{\forall k, k \neq j} \rho_r^k(d_k - r) \right] \binom{n}{r}^{-1} \binom{d_j}{r}. \quad (12)$$

The following recurrence relation is easier to implement with spread sheet software:

$$\rho_r^j(\mathbf{d}) = \frac{d_j}{n} \rho_r^*(d_j - 1) + \left[\frac{n - d_j}{n - r} - \rho_r^*(d_j - r) + \rho_r^j(d_j - r) \right] \binom{n}{r}^{-1} \binom{d_j}{r}, \text{ for } j=1, 2, \dots, m. \quad (13)$$

The boundary condition can be shown to be

$$\rho_r^j(\mathbf{d}) = \begin{cases} 0 & \text{if } d_j = n < r \\ 1 & \text{if } d_j = n \geq r. \end{cases} \quad (14)$$

5. CONCLUDING REMARKS

In this paper, we proposed several types of run tests for the sequence of outcomes or elements of *more than two* kinds. In a multinomial process with three types of elements, for example, each of three different elements {A, B, C} is presented with probabilities, p_1 , p_2 , and p_3 . In a hypergeometric process with four types of elements of size d_1 , d_2 , d_3 , and d_4 , we assume that all the elements {A, B, C, D} are mixed together and arranged in random order. In both cases, we can use the number of runs and the maximum run length to test the randomness of the ordered sequence of outcomes and elements of more than two kinds.

The theory of runs has grown markedly in popularity and in a variety of applications. Various run tests have been used to check for randomness in a sample distribution, to examine a distribution of regression residuals for non-randomness, to test for both trends and cyclical patterns with temporal data, and to test the association between two variables. Although a run test is known as a “quick and dirty” method, it is popular due to its simplicity of use and its versatility in a wide variety of applications.

One of the popular application areas is statistical process control [4] and sampling inspection [3]. Most job-shops are characterized by short production runs, and many of these shops produce parts on production runs of less than 50 units. In such a job-shop manufacturing environment, the routine use of traditional control charts and hypothesis testing methods appear to be somewhat of a challenge, as not enough units are produced in any one batch to estimate the population distribution and its parameter values.

In such a job-shop environment with short production runs, practitioners can use our non-parametric run tests developed for nominal data with more than two classes. Furthermore, Our

unified approach that is based on the recursive equations can be easily implemented with any spreadsheet software such as Microsoft Excel.

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USING DATA VISUALIZATION TO VIEW THE IMPACT OF CONSOLIDATION ON ONE BBA PROGRAM

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ABSTRACT

Until recently, consolidations of academic institutions were rare. Therefore, consolidating institutions find few models to follow and little history to provide guidance. This paper uses data visualization to look at the impact of consolidation on the BBA program at the University of North Georgia. The study considers student performance (pre- and post-consolidation), student enrollment trends (in terms of headcounts), and demand for instruction (in terms of credit hours). Although the analysis is descriptive in nature, the patterns that emerge provide insight that may be used as input into the planning process for program delivery.

INTRODUCTION

On January 5, 2012, the University System of Georgia Board of Regents confirmed rumors that the Board of Regents would be voting on the consolidation of four pairs of institutions (August State/Medical College; Gainesville State/North Georgia; Macon State/Middle Georgia; South Georgia/Waycross) [1]. The following week the Board of Regents approved the recommendation and gave a January 2013 date for consolidation to become official [2]. This paper uses data visualization to focus on the BBA program at the University of North Georgia. See the Appendix for a more complete timeline.

The University of North Georgia consolidated North Georgia College & State University, a Senior Military College located in Dahlonega, Georgia, and Gainesville State College, an access institution with the main campus in Oakwood and a satellite campus in Watkinsville, Georgia. Prior to the announced consolidation, the two had collaborated in a number of academic programs including working together to open a new joint campus in Cumming, Georgia and providing several 2+2 programs. Students in the 2+2 programs could earn a bachelor's degree by taking lower level coursework provided by Gainesville State College and upper level coursework provided North Georgia College & State University on the Gainesville campus.

The BBA program was the largest and longest running 2+2 program on the Gainesville State campus—having been in operation since 1984. Data from this program provides some insight into the potential results of combining programs with different cultures and admission standards. Generalization from any analysis to other institutions is questionable, but the methods of analysis may transcend this specific case.

HISTORY

Prior to consolidation, both Gainesville State College (GSC) and North Georgia College & State University (NGCSU) had strong academic reputations and ranked high in student retention and

graduation rates. Gainesville State College, founded in 1964 in Oakwood, GA as a junior college, was considered an access institution and evolved into a commuter school that offered a variety of associate's degrees and a limited number of bachelor's degrees. North Georgia College & State University, founded in 1857 in Dahlonega, GA as North Georgia Agricultural College, was a comprehensive university with selective admissions and evolved into one of the six senior military colleges in the nation and offered a variety of bachelor's and master's degrees as well as a doctorate in Physical Therapy. At the time of consolidation, GSC enrolled approximately 9000 students, and NGCSU enrolled approximately 6000 students. The main campuses of the schools are approximately 30 miles apart, and both drew the majority of their students from the same geographic region. Many GSC students transferred to NGCSU to complete their bachelor's degree.

The announcement of the consolidation of the two institutions identified opportunities and challenges for the unified school [3]. Opportunities included providing a more seamless system of education for a fast growing geographic region of the state, building on existing collaborations and partnerships, and expanding bachelor's and graduate offerings in Gainesville to relieve some of the capacity constraints on the Dahlonega campus. The major challenges identified were the need to balance the competing access and college completion expectations and to optimize the offerings on each campus (Gainesville, Dahlonega and additional campuses in Watkinsville and Cumming) [4]. Addressing the access challenge has resulted in separate admission processes and fee structures for Associate's degree seeking students and other students.

Prior to consolidation, the Business programs from the two institutions had a long history of collaboration. Since 1984, NGCSU had offered a part-time evening BBA program on the GSC campus. Through this program, GSC provided lower level (Freshmen/Sophomore) courses required for the BBA degree and NGCSU faculty travelled to the GSC campus to teach the upper level courses needed for the BBA degree. The NGCSU BBA program on the Gainesville campus was open to any student admitted to NGCSU who met the prerequisites for the courses. The program drew transfer students from GSC and other schools who took all of their courses through this part-time, evening program as well as some students who took the majority of their courses during the day on the main campus of NGCSU and augmented their schedule with additional courses on the GSC campus. At the time of consolidation, approximately 100-120 BBA students were taking classes exclusively on the GSC campus and approximately 30-50 additional students included at least one Gainesville class along with courses on the main campus. This pre-existing relationship provides some opportunities for assessing the impact of consolidation on the BBA program.

DATA VISUALIZATION

Data visualization is not new. The expression, "A picture is worth a thousand words" is of an unknown origin but dates back to at least the early 1900's. Tufte [5] opened his landmark book with the following, "Often the most effective way to describe, explore, and summarize a set of numbers—even a very large set—is to look at pictures of those numbers. Of all methods for analyzing and communicating statistical information, well-designed data graphics are usually the simplest and at the same time the most powerful."

Although the resulting graphs may provide information in a simple format, collecting and displaying the data in a way that communicates the story can be a daunting task. The process of focusing on appropriate questions to explore, finding and accessing available data, combining data from multiple sites, cleaning the data, and creating the graphics is a combination of art, science, technical knowledge, and subject matter knowledge.

Scope and Focus of this Study

This study focuses on the BBA program at the consolidated university and the impact of consolidation on this one degree program. Areas of interest include student performance, student enrollment (in terms of number of students by major), and demand for instruction (in terms of credit hour production). Since the AA in Business is the natural lead-in to the BBA program, data from this program is included in the analysis. This study uses student level data and course level data for Fall and Spring semesters of Fall 2009 through Fall 2014. This time-frame includes five semesters before consolidation was announced, three semesters of transition (including one where the consolidation was official but the daily operations affecting students were still based on the legacy databases), and three semesters operating under combined systems.

Data

Although the BBA program is the largest bachelor's program offered by the College of Business, considering this program in isolation requires some decisions that impact what data to use, what questions can be answered, and what conclusions can be drawn. Pre-consolidation, students at GSC who were planning to earn a BBA degree were enrolled in the AA in Business program and these students would transfer to NGCSU or another institution to complete the BBA degree; students at NGCSU could declare a major in the BBA program as incoming freshmen or through the change of major process after they were enrolled. To allow for comparisons across the full academic program, data from the AA program (student and instruction related) were included in this study. Courses included in the study were limited to ones taught through the Business departments to meet lower level foundation requirements and upper level requirements for the BBA degree. In addition, since Business Communication is required for the BBA and is populated almost exclusively by Business students, all sections of Business Communications were included regardless of where they were taught. The same approach did not work in the case of the Information Technology/Computer Application course students took at the two schools. At NGCSU, students took a course taught outside of Business that was a popular option for all students in the General Education curriculum and data from this course was omitted.

In order to compare pre-consolidation and post-consolidation characteristics, pre-consolidation data were drawn from reports generated by GSC and NGCSU Banner systems; and post-consolidation data came from the corresponding reports in the UNG Banner system. Even though both schools were part of the same University System and both used Banner, the implementation and available reports differed greatly. For example, names of variables differed between schools or even between reports from the same school—sometimes having different names for the same characteristic (e.g., current hours vs. enrolled hours) and other times using the same name to represent different characteristics (e.g., enrollment with or without Withdrawals counted). In addition, using reports with data for specific semester that were

intended for use as monitoring reports during the semester described did not always function well as a historical picture of that semester. For example, there were several cases where student characteristics related to a specific previous semester provided information that matched the student characteristic on the day the report was pulled (rather than during the semester listed for the report (e.g., student age and earned hours).

In addition to issues related to using the data available, there were issues where different academic policies would impact the interpretation of the results (e.g., how GPAs were impacted by grades in repeated courses), other places where the level of detail varied from school to school, and places where no one had a clear enough crystal ball to have collect historical data that would be useful for analyzing consolidation questions. Likewise, many of the pre-consolidation reports were the basis for reports at the consolidated university but lacked some new additional information—most notably identification of students who have transitioned from Associates level to Bachelors level and home campus for students.

Obtaining appropriate data and cleaning the data became a much bigger challenge than originally expected! Three primary data sets were used for analysis: 1) data related to all Senior BBA students when consolidation was announced in Spring 2012—to evaluate how transfer students had performed in upper level BBA courses relative to native students, 2) data related to BBA and AA students between Fall 2009 and Fall 2014—to evaluate questions related to size of the BBA student body and how they tie to different majors, different class levels, and different campuses, and 3) data related to course enrollments for the same time period—to evaluate credit hour production overall and by campus, discipline, and placement within the BBA degree. All analysis was done using JMP Pro 11, and all graphs were constructed using JMP Pro 11 or Microsoft Excel.

STUDENT PERFORMANCE

Pre-Consolidation

In January 2012 when consolidation was announced, the university community was caught by surprise. Just about everyone had some view of how combining the student bodies would (or would not) work. There was little recognition of how many students in the NGCSU student body were transfers from GSC. In an effort to take an objective look at how Gainesville transfers performed in the BBA program and to bring a current “hot topic” with students to the classroom, students in a business statistics class used regression analysis to comparing native students and Gainesville transfer students. The goal was to determine how performance in advanced courses compared for native and GSC transfer students. The results of this study along with a few extensions beyond the class project are used for this part of the analysis.

The study looked at the 341 BBA Seniors in Spring 2012 and found that 75 were native students who had completed all of their coursework through NGCSU, 118 had at least 15 semester hours credit from GSC were considered GSC transfers (with an average of more than 60 semester hours completed at GSC), 91 non-GSC transfers had at least 15 semester hours of credit from other schools and were considered as transfers from other schools, and 57 had limited transfer hours (<15 hours through transient, credit by exam, etc.). Through a review of individual student

records of Seniors with at least 30 earned hours at NGCSU, data were collected on a stratified random sample of students from each of the four BBA majors for native students and for GSC transfers. In addition to transfer status and major, data were also collected (or calculated) to show each student's GPA in the first part of their academic career and the student's GPA for the later part of their academic career. For transfer students, the "Lower Level GPA" was their transfer GPA; and the "Upper Level GPA" was their institutional GPA. For native students, the "Lower Level GPA" was their overall GPA at the end of the semester they were closest to 60 earned hours; and the "Upper Level GPA" was the GPA calculated from the remainder of their coursework.

The goal was to determine if there was a difference between the performance of GSC transfers and native students in the advanced work for the BBA degree. Therefore, graphical analysis focused on the Upper Level GPA for Native vs. GSC transfer students. The Box Plots in Figures 1 and 2 show that the medians were very close for Native students and GSC Transfer students with a slightly higher median and slightly more variability in GPAs for the GSC transfers at the end of their lower level coursework and as Seniors at NGCSU.

Figure 1: Lower Level GPA - Natives vs. GSC Transfers

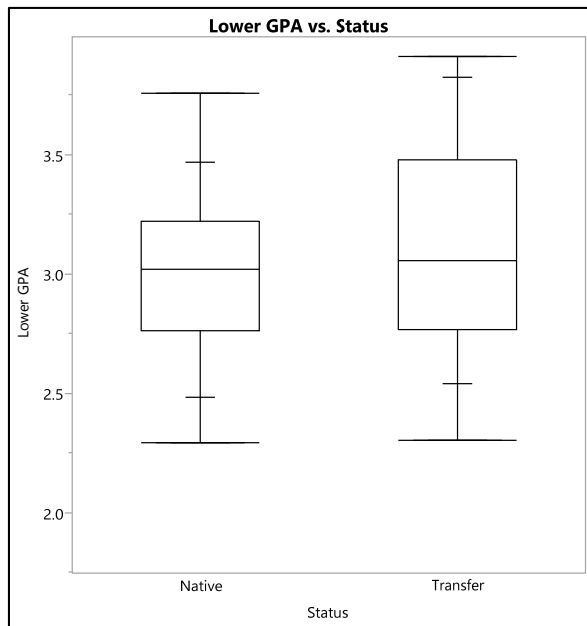
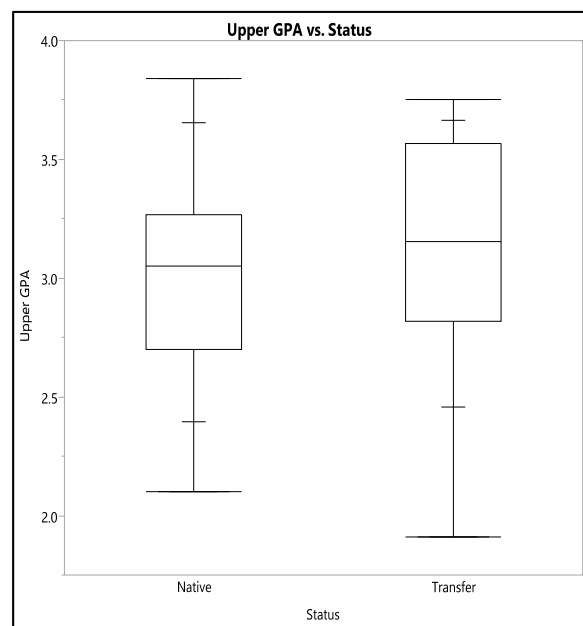


Figure 2: Upper Level GPA - Natives vs. GSC Transfers



Figures 3 and 4 break the analysis down to further to see if there are differences between the Native students and GSC transfers based on their selected major. Although Figure 3 shows that the medians for the students in the sample differ between Native and GSC transfer students, the large variation in both groups makes generalization difficult. Figure 4 provides results of statistical comparisons between the two majors (Finance and Management) where there appears that differences may exist in upper level performance. With p values of .25 and .74 respectively, there is not sufficient evidence to support a statement that the Native and GSC transfer students perform differently.

Figure 3: Upper Level GPA Native vs. GSC Transfer GPA by Major

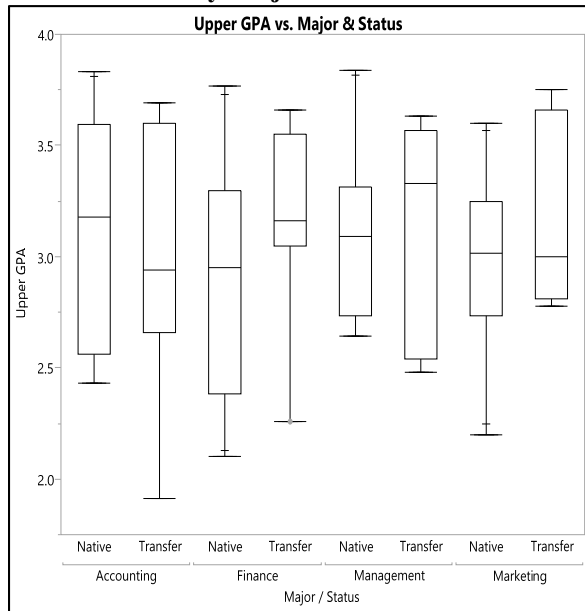
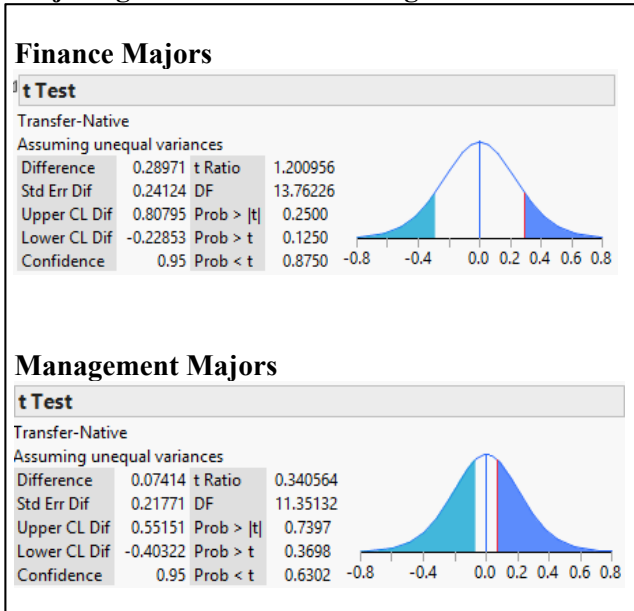


Figure 4: Comparing Native and GSC Transfers Majoring in Finance and Management



Figures 5 and 6 look at the relationship between a student’s Lower Level GPA and Upper Level GPA. In Figure 5, comparing two graphs in same row shows the similarity of performance of Native students and GSC Transfer students for the major represented in that row; and comparing the four graphs in the same column shows the similarity of performance of different majors with the same transfer status. In both cases (across rows or down columns), few differences are visible. Figure 6 differentiates the transfer status for each student based on the color of the point, but illustrates the relationship between Lower Level GPA and Upper Level GPA without regard for transfer status or major. Both groups show lower level GPAs across the full range with no noticeable patterns based on transfer status.

Figure 5: Lower Level GPA as a Predictor of Upper Level GPA by Transfer Status and Major

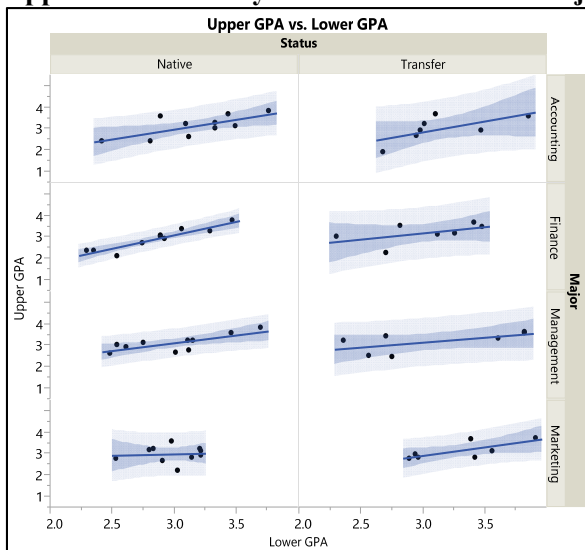
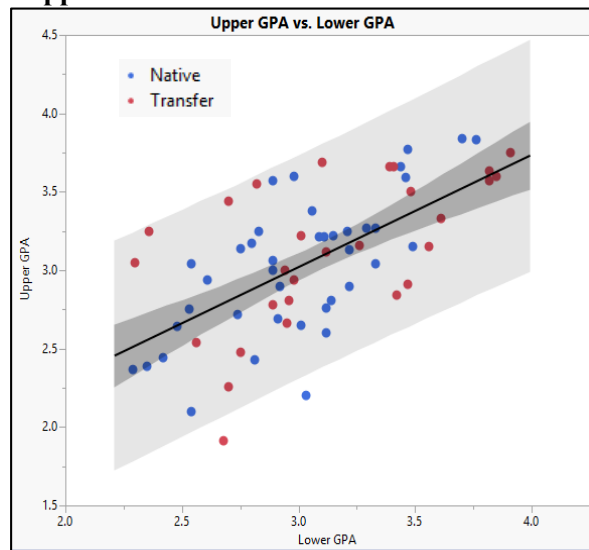


Figure 6: Lower Level GPA as a Predictor of Upper Level GPA



Stepwise regression was used to follow up on the visual evidence related to the relationship seen in Figures 5 and 6. Using a backward approach where Lower Level GPA, Major, Transfer Status, and all of the potential two way interactions were considered provided results that are consistent with the visual conclusions. The resulting recommended model included Lower Level GPA as the only predictor. [Upper GPA = .877 + .716Lower GPA]

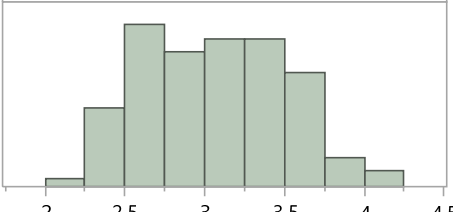
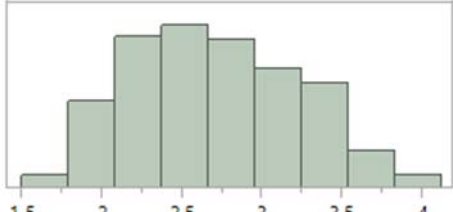
Pre- and Post-Consolidation Comparisons

If Lower Level GPA appeared to be a significant predictor of performance of Upper Level GPA, has the distribution of Lower Level GPAs or the relationship between Lower Level and Upper Level GPA changed?

The extension of the 2012 analysis to the consolidated university cannot be applied blindly. The 2012 analysis limited analysis to students who actually transferred and continued to progress through the program to become seniors. Some students who enrolled at GSC did not continue beyond the AA program, some transferred elsewhere, some enrolled at NGCSU but were not retained, and some continued through to their Senior year. Data were only available on the students who continued to their Senior year. Also, data about which students have transitioned from the AA program to the BBA program at UNG is difficult to obtain. And finally, UNG has not been in existence long enough to conduct a study similar to the one done in 2012 even if the data were available.

Figure 7 attempts to compare the distribution of Lower Level GPAs for “Transfer” students at two points in time—Spring 2012 when consolidation was announced and Fall 2014 for AA degree seeking students who are nearing the time that they would transition to a bachelor’s degree program. The pre-consolidation data includes the Transfer GPA for all GSC BBA transfer students who were Seniors enrolled at NGCSU in Spring 2012; and omits all other students who attended GSC. The post-consolidation data includes all UNG students listed as AA students in Business who have completed less than 45 semester hours in Fall 2014 and omits any student who has already transitioned to bachelor’s status.

Figure 7: “Transfer” Student Lower Level GPAs

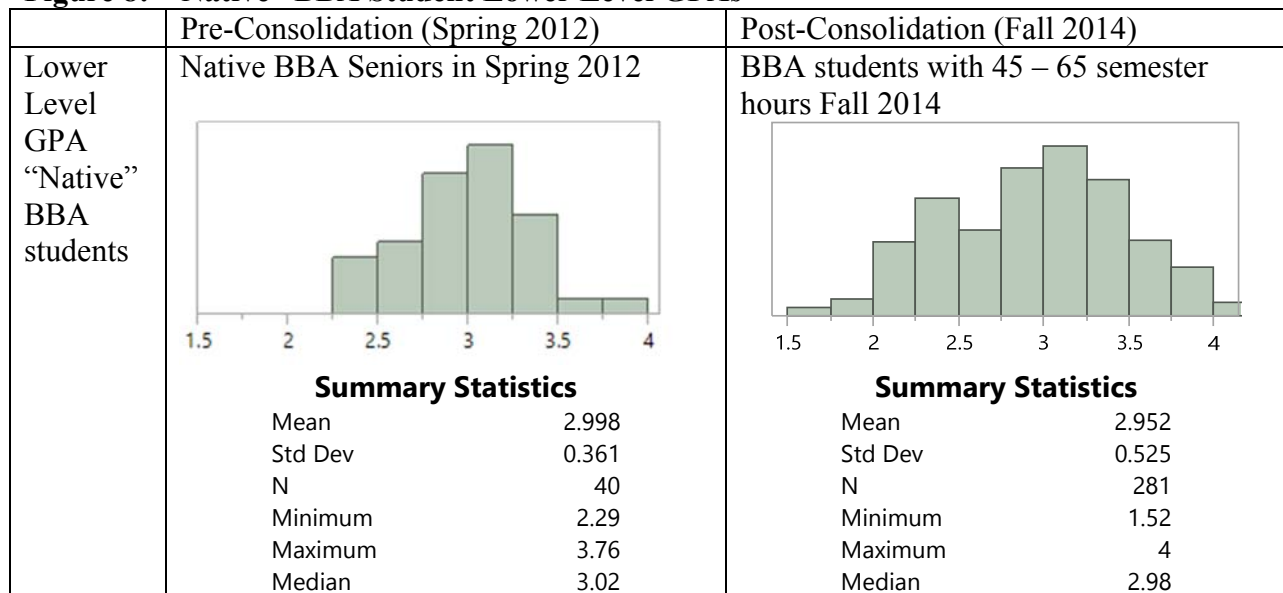
| | Pre-Consolidation (Spring 2012) | Post-Consolidation (Fall 2014) |
|--|--|--|
| Lower Level GPA “Transfer” Students | Transfer GPA for Spring 2012 Senior BBAs who had transferred to NGCSU  | GPA for AA students with at least 45 hours  |
| | Summary Statistics Mean 3.062 Std Dev 0.441 N 118 Minimum 2.222 Maximum 4 Median 3.084 | Summary Statistics Mean 2.715 Std Dev 0.525 N 280 Minimum 1.6 Maximum 4 Median 2.67 |

The differences between the students used to assess the similarities between pre- and post-consolidation GPAs make comparisons questionable. Since students who were more academically challenged would be less likely to continue their education, the Spring 2012 distribution would probably show higher GPAs than would be seen for the entire population of students who had enrolled as AA students in Business at GSC. Similarly, since GPA is one of the criteria for being allowed to transition from Associates to Bachelors level and since some students (especially academically weak ones) will not elect to continue beyond the AA, the Fall 2014 distribution would probably show lower GPAs than would be seen for the population of students who would actually transition to the BBA.

Figure 7 shows that the distribution of GPAs is lower for the group included post-consolidation. Unfortunately, there is no way to determine if this is due to the mismatch between all AA students and those that transitioned to the BBA at UNG or if this is due to a shift in the performance of students in general.

Figure 8 attempts to compare the distribution of Lower Level GPAs for students who started at UNG as BBA degree seeking students at two points in time—Spring 2012 when consolidation was announced and Fall 2014 for BBA degree seeking students at a point in time when they would start taking upper level courses. The pre-consolidation data includes the Lower Level GPAs for Native students who were in the sample for the Spring 2012 study. The Spring 2012 student did not obtain Lower Level GPAs for the other Native students. The post-consolidation data includes the current overall GPA for all Fall 2014 UNG students with 45 to 65 earned hours. Since students must be classified as bachelor’s degree seeking to enroll in upper level courses, this group would include some students who have already transitioned from the AA program. In addition, students who transferred to UNG from other schools would be included.

Figure 8: “Native” BBA Student Lower Level GPAs



The differences between the students used to assess the similarities between pre- and post-consolidation GPAs make comparison questionable. Figure 8 shows the two groups to be similar

in terms of mean GPA, but different in terms of variability. The increased variation in the post-consolidation GPAs could be a function of the small sample size pre-consolidation, inclusion of students who had already transitioned to the BBA, or changes in the variation in students admitted to UNG as BBA degree seeking.

Unfortunately at this point in time and with the data currently available, using the results from the 2012 study to evaluate and estimate if student performance differs based on the two paths for admission to the university requires assumptions that cannot be confirmed.

Describing characteristics of UNG student performance (without attempting to explain what influences these characteristics) may be insightful. Figures 9 and 10 look at GPAs for students based on whether they are preparing for major level coursework or currently in upper level BBA coursework. Figure 9 looks at all students who are in programs preparing for upper level coursework in the BBA (sometimes referred to as pre-Business) and allows for comparisons between students classified as Associate’s degree seeking and those classified as Bachelor’s degree seeking. In addition to Freshmen and Sophomore BBA students, the histograms in Figure 9 includes all AA in Business students since these students must transition to Bachelors level prior to enrolling in any upper level BBA courses. The histogram shows that the majority of pre-Business students at UNG are classified as Associate’s degree seeking. Based on decisions made during the consolidation process, we know that the home campus for the Associate’s degree seeking students is not Dahlonega. We cannot make a parallel statement for the BBA students—since general education is available on all four campuses and students admitted as Bachelor’s degree seeking can claim any campus as their home. At present, BBA students who continue to upper level will need to take classes on the Dahlonega and/or Oakwood campuses. The summary statistics that accompany the charts show that AA students with more than 60 earned hours have higher GPAs. Attrition of students who were struggling may influence this number. For students in the BBA program as Freshmen and Sophomores, students on the Gainesville campus have slightly higher GPAs and also higher variability.

Figure 9: GPA for all AA in Business Students and Lower Level BBA Students (GPAs are at the end of Spring 2014)

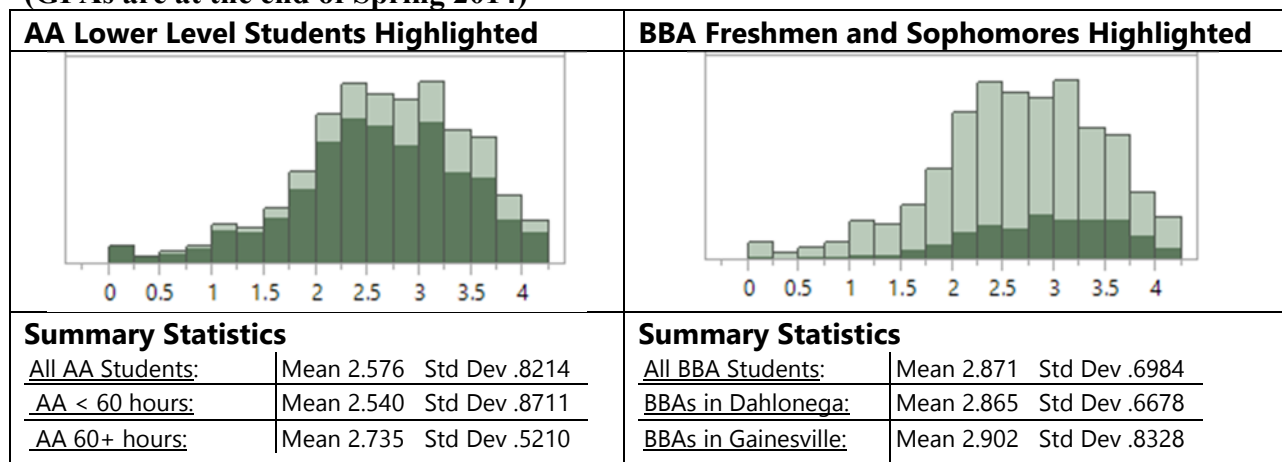
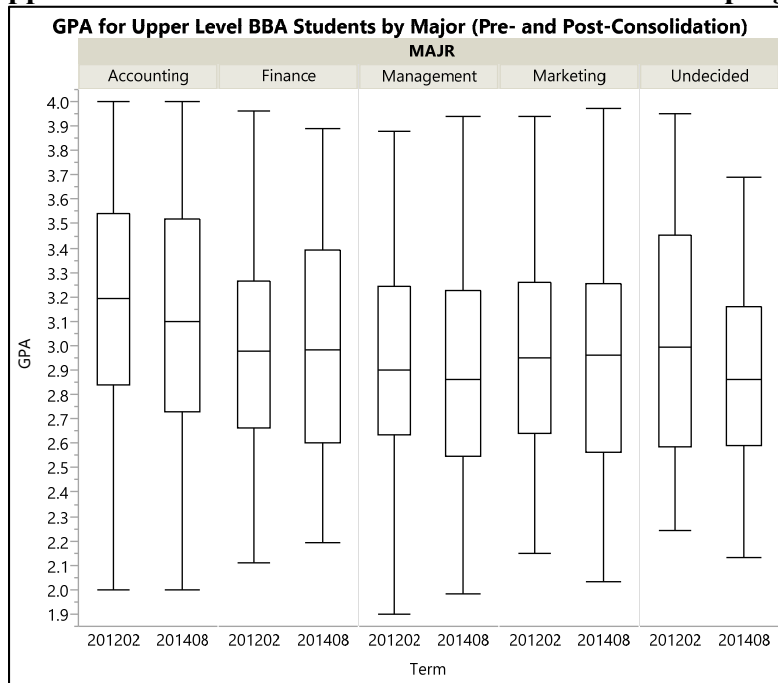


Figure 10 compares GPAs for all Junior and Senior BBA students in each major in Spring 2012 to the same groups in Fall 2014. Only slight changes can be seen pre-consolidation to post-consolidation for any of the majors.

Figure 10: Overall GPAs for Upper Level BBA Students by Major Pre- and Post-Consolidation (Upper Level refers to Juniors and Seniors in the BBA program)



STUDENT ENROLLMENT

Providing the appropriate classes (and more specifically seats in classes) for students to make timely progress toward graduation requires accounting for the number of students in each program and the number of classes each student will take in a term. With multiple campuses and multiple majors, understanding how students are distributed across majors and campuses makes the forecast more complicated. This section explores ways to view the number of students in the program. Much of the analysis looks for trends in demand for courses; therefore, Run Charts are the primary tool used for exploration. All of these charts show a vertical line at the start of Fall 2013. Although the consolidation became official in January 2013, Fall 2013 was the first semester that students were admitted and registered in the combined UNG Banner system. All enrollment prior to this was entered through the GSC or NGCSU Banner system based on the institution that offered the program—thus all of the BBA students listed on the Gainesville campus prior to Fall 2013 were admitted to NGCSU, paid tuition and fees to NGCSU, were taught by faculty from NGCSU, receive any financial aid through NGCSU, and had their grades and credit recorded on a NGCSU transcript—but attended class in buildings on the GSC campus.

Transfer Admissions

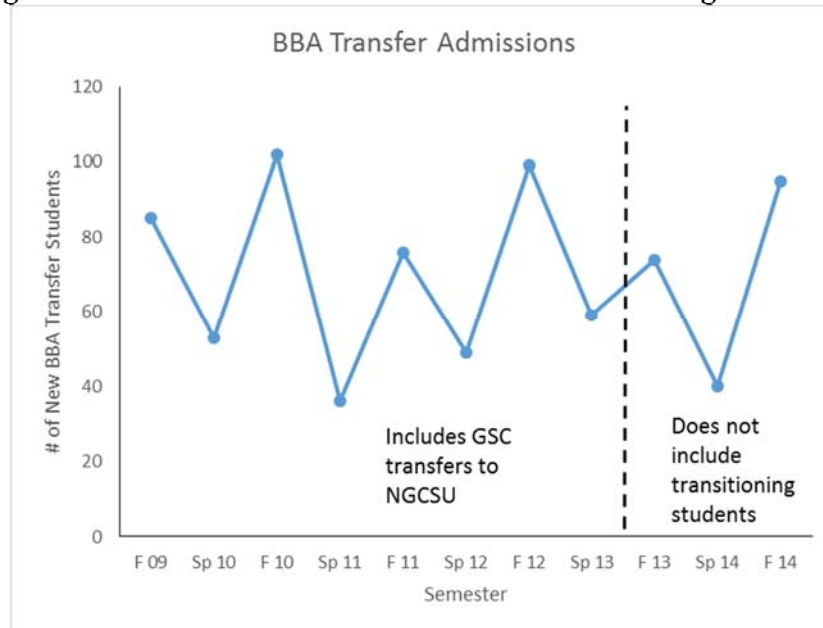
Prior to consolidation, the BBA program at NGCSU had a large number of transfer students entering the program—with GSC being the most common transfer institution. With

consolidation, the GSC students are part of UNG. Post-consolidation students can apply as Bachelor’s degree seeking students as incoming Freshman, register for lower level classes on any campus, and pay Bachelor’s level tuition and fees; or they can apply as Associate’s degree seeking students, register for lower level classes on any campus other than Dahlonega, pay Associates level tuition and fees, and transition to Bachelor’s degree seeking once they meet certain requirements. The expectation was that the number of transfer students coming into the BBA program would go down.

In Spring 2012 when the consolidation was announced, there were 341 senior BBA students. Of these, there were only 75 students who had earned all of their credit from North Georgia College & State University; 209 students had earned at least 15 hours of transfer credit; and of these 118 were considered Gainesville State College transfers. Of the Gainesville transfers, 61 enrolled in classes on the Dahlonega campus and the remaining 57 were in the part-time evening program on the Gainesville campus.

After consolidations, the students that were previously considered GSC transfers “transition” from the Associates level to Bachelors level and are not considered as transfers. Figure 11 shows the number of transfer students admitted as BBA students since Fall 2009. As would be expected, there are more transfer students admitted in Fall semesters. Contrary to expectation, the total number of transfer students admitted as BBA students did not drop noticeably following consolidation.

Figure 11: Number of Students Admitted as BBA Degree Seeking



BBA Students by Campus

Currently, the upper level courses for the BBA program are available on the Dahlonega campus (mostly day classes) and on the Gainesville campus (mostly in the evening with a frequency designed for part-time students). Prior to consolidation, all BBA students were enrolled at NGCSU. Part of these students identified themselves as intending to take all of their courses in

the evening program on the GSC campus. These students were assigned to an advisor and were referred to as “Gainesville students.” In Spring 2012, approximately 19% of the Senior BBA students and 10% of Junior BBA students were identified as Gainesville students. Some other NGCSU BBA students would take part of their classes on the Gainesville campus, but these student were considered as “Dahlongega students.” Post consolidation, the data available did not distinguish between students taking all classes on one campus as opposed to taking classes on multiple campuses. Also, students were allowed to express a preference for any campus—even if the degree they were pursuing was not available on that campus! For this analysis campus designation is based on the location where the student is assigned for advising and combines BBA students advised on the Oconee Campus with those advised in Gainesville. As Figure 12 illustrates, as of Fall 2014, there number of BBA majors has grown on both campuses. The distribution across campuses has shifted so that 30% of BBA Seniors and 39.5% of BBA Juniors consider Gainesville as their home campus. Figures 13 looks at the trend in campus enrollments for both the AA and BBA programs combined.

Figure 12: BBA Students by Campus

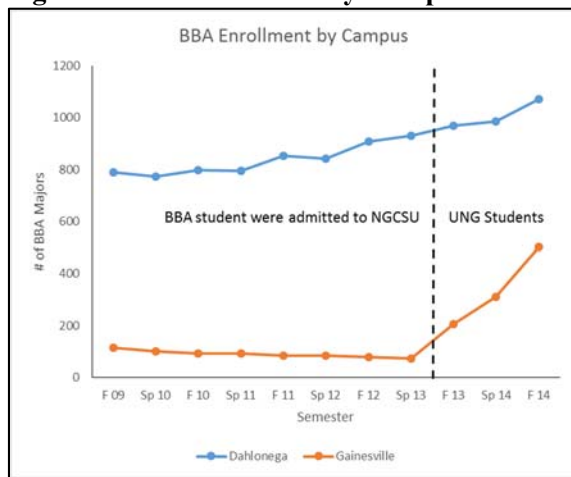
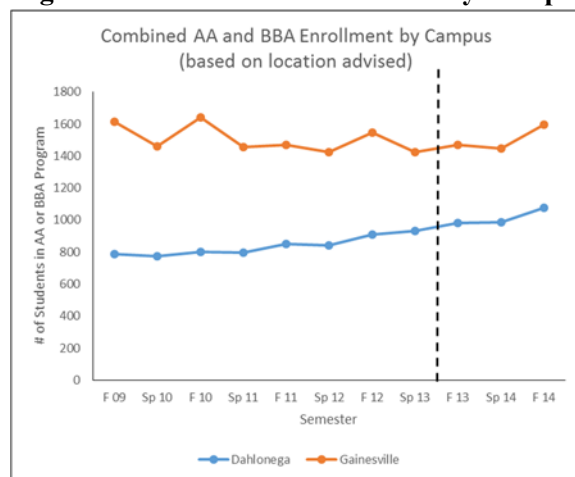


Figure 13: BBA and AA Students by Campus



*Figures 12 and 13 group Oconee and Gainesville together

BBA Students by Program, Major, and Class Level

Figure 14 consists of six charts that are interconnected. Figure 14a shows the combined enrollment in the two programs. The total enrollment is up 8.9% since the consolidation became official and 17.9% since the Board of Regents announced the consolidation. Figures 14b and 14c show that enrollment in the AA degree has decreased while enrollment in the BBA degree has risen steadily following consolidation. Figures 14b and 14d together represent the lower level students who are on a path that leads toward the BBA degree. Figures 14d and 14e show how students are distributed across the majors in the BBA program. Figure 14f provides a somewhat puzzling view of the enrollment—how can each class be larger than the class that “feeds” it—students cannot skip a year of college! Part of the explanation relates to the number of students who enter the university as non-BBA majors (including AA students) and part can be explained by the fact that many students take more than 4 years to move through the program.

Figure 14: BBA and Prospective BBA Students by Major and Campus

Figure 14a: Total Number of BBA Path Students

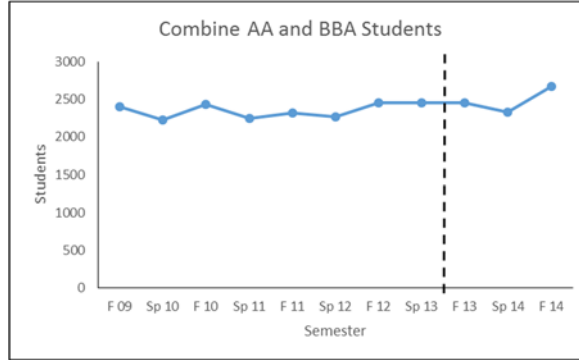


Figure 14b: AA in Business Degree Seeking

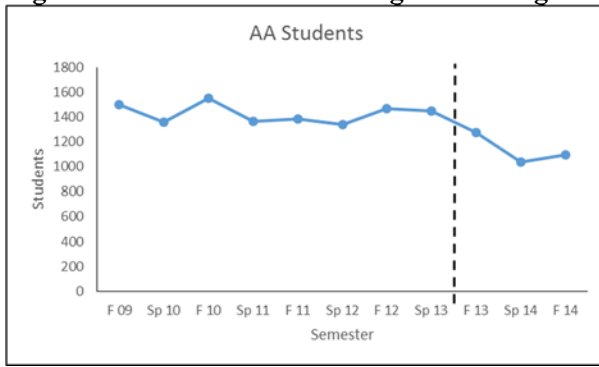


Figure 14c: BBA Degree Seeking

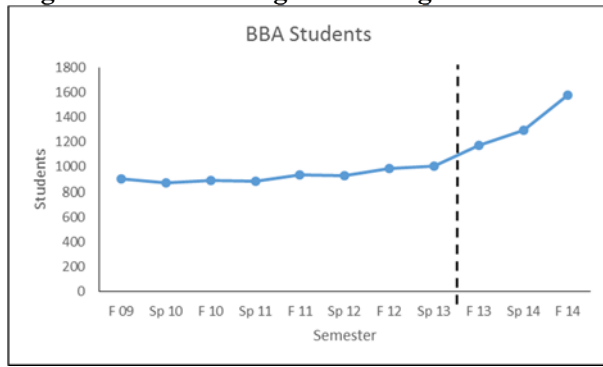


Figure 14d: BBA Lower Level Students by Major

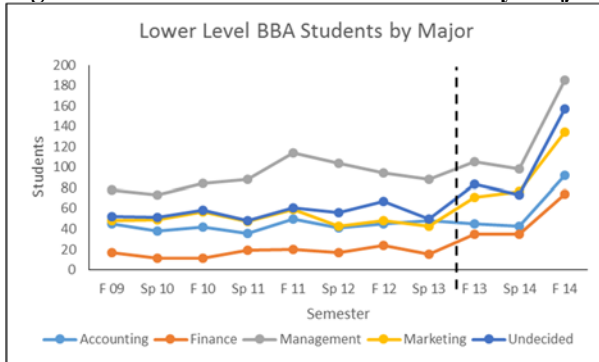


Figure 14e: BBA Upper Level Students by Major

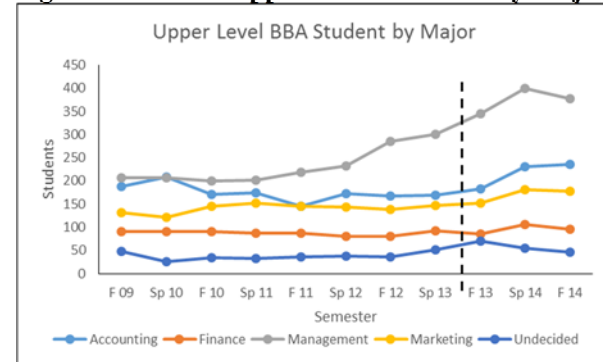


Figure 14f: BBA Students by Class Level

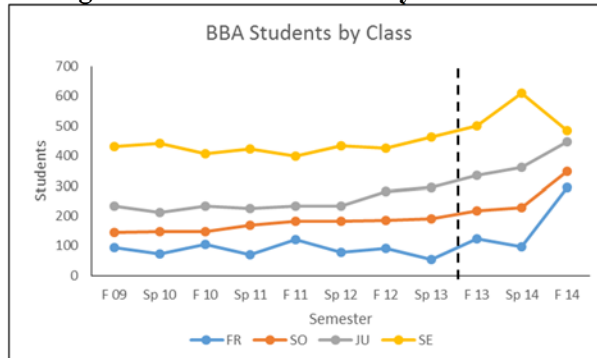


Figure 15 provides a snapshot that reinforces some of the anecdotal evidence related to students' desires for growth on the Gainesville campus. That most of the Freshmen and Sophomore BBA students are on the Dhalonega campus is not a surprise. The AA in Business is not available in Dhalonega; and BBA and AA students on the Gainesville campus have the opportunity to take the same lower level classes (at a lower tuition). The growth in the proportion of Junior and Senior BBA students selecting the Gainesville campus is surprising given that the median (and mode) course load for these students is 12 semester hours (as shown in Figure 16). At present, the BBA program on that campus is still provided on a schedule that is geared to part-time students. The low proportion of Marketing majors listing Gainesville as their home campus may be related to the fact that NGCSU discontinued the Marketing major on the Gainesville campus approximately five years ago. At a recent career fair on the Gainesville campus, there was considerable interest in this major.

Figure 15: Fall 2014 Distribution of BBA Students Across Campuses and Class Level by Major

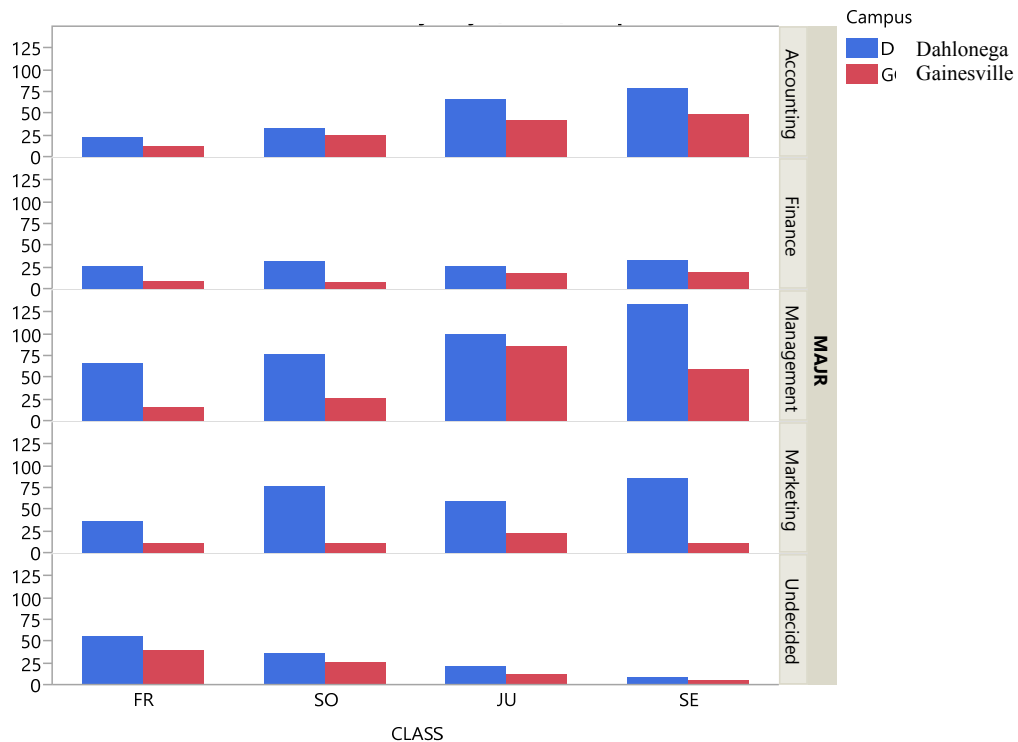


Figure 16a: Fall 2014 Enrolled hours - Dahlonega BBAs

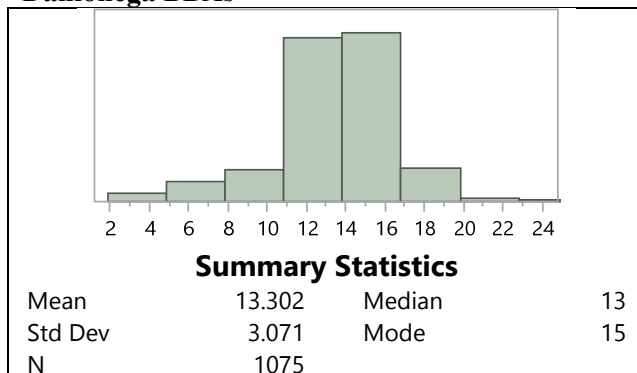
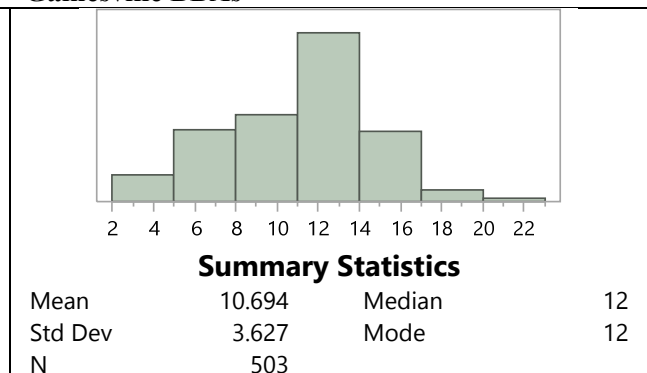


Figure 16a: Fall 2014 Enrolled hours - Gainesville BBAs

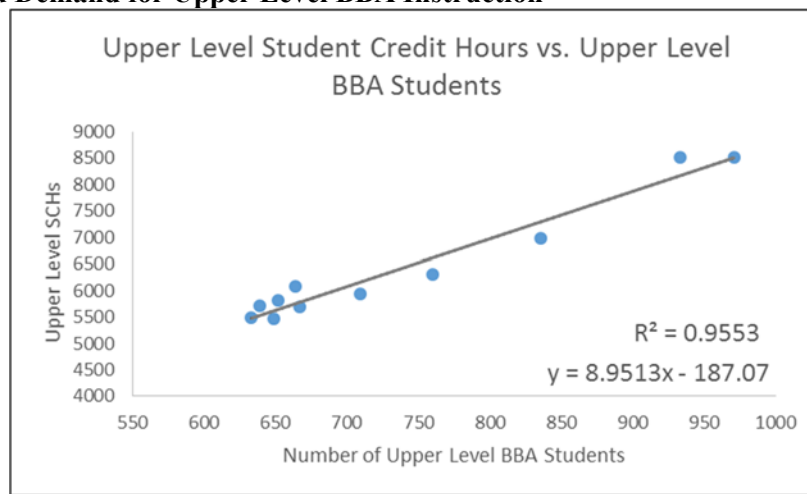


DEMAND FOR INSTRUCTION

Relationship Between Number of Majors and Enrollment in Courses

Translating number of students in specific majors into expected demand for classes can be a challenge—especially when some of the courses are included in multiple majors across campus. Figure 17 shows a strong relationship between the number of upper level BBA students and the number of credit hours of instruction in upper level BBA courses. Unfortunately, even a strong relationship between the number of students and credit hours provided does not direct action to determine the specific courses that need to be offer nor verify that the appropriate number of seats were available in the past.

Figure 17: Relationship Between Number of Upper Level BBA Students and Demand for Upper Level BBA Instruction



Patterns in Enrollment Data

Looking at student credit hour production (SCH) provides a better estimate than the number of students for forecasting course enrollment. As was the case with counts of students, Run Charts are the primary method used to illustrate emerging trends. All charts cover the Fall 2009 to Fall 2014 period. In order to recognize where the institutions were in the consolidation process and how students registered each of the charts presented is partitioned into three periods:

- “Separate” refers to all semesters up to and including Spring 2012. During this period students registered for courses as students in separate institutions with no knowledge that this would be different in the future. Spring 2012 is included in this segment since consolidation was announced after registration closed for Spring 2012
- “Transition” refers to academic year 12/13 (Fall 2012 and Spring 2013). This is the period when consolidation had been announced, but students were still admitted and registered through separate systems. In Fall 2012, the institutions were still officially separate; UNG was officially “born” on January 8, 2013, but daily practices for students were still tied to the old systems.

- “Combined” refers to Fall 2013 and more recent. During these semesters, all registration was conducted through a single Banner system with fewer restrictions on taking courses across lines that had separated the institutions.

Figure 18 provides an overview of the ways that credit hours can be subdivided. Figure 19 illustrates the trend for total student credit hours in the AA and BBA programs. Figures 20 – 25 look at the various subsets of student credit hours to provide alternative views of characteristics that may influence demand.

Figure 18: Roadmap for Gaining Insight into Historical Demand for Instruction

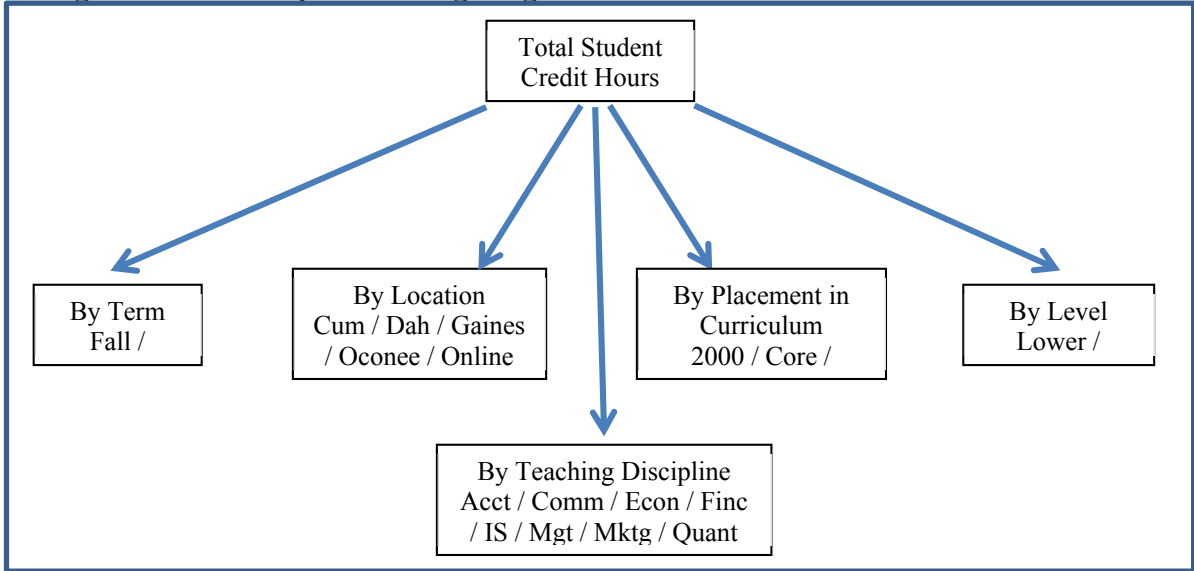


Figure 19: Total Student Credit Hours

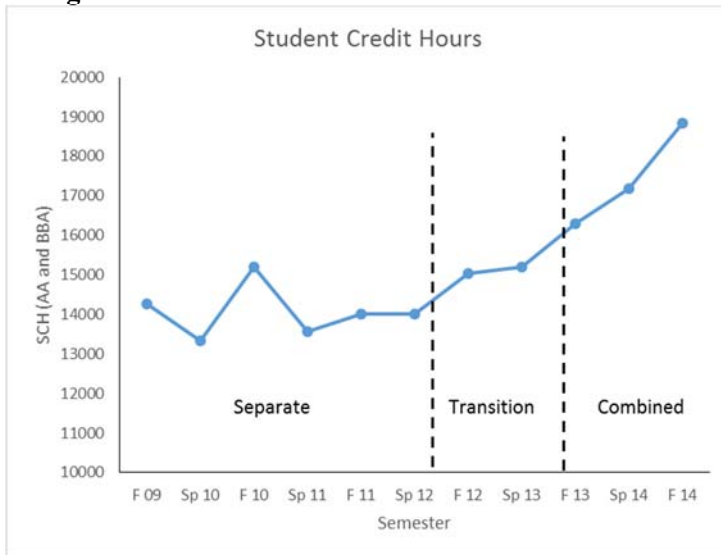
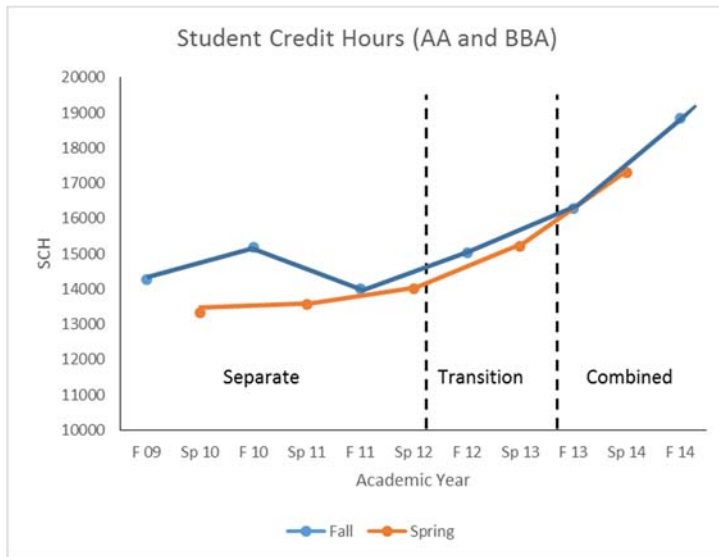


Table 1: One Semester and One Year (AA and BBA Courses Combined)

| | Over previous semester | Over previous year |
|-------|------------------------|--------------------|
| F 12 | 7.4% | 7.3% |
| Sp 13 | 1.2% | 8.6% |
| F 13 | 7.1% | 8.3% |
| Sp 14 | 5.5% | 13.0% |
| F 14 | 9.6% | 15.7% |

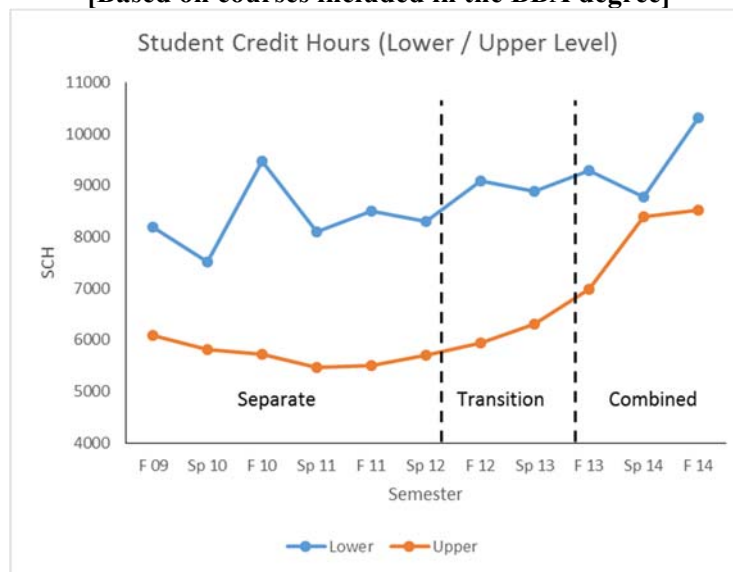
Student credit hours increased by 34.5% between Spring 2012 (when consolidation was announced) and Fall 2014.

Figure 20: Student Credit Hours by Academic Term



Both Fall and Spring Credit Hours have risen steadily since consolidation was announced. For the two years prior to consolidation, Fall enrollments had been higher than Spring enrollments. Since the announcement of consolidation, each semester has been up from the previous semester.

Figure 21: Student Credit Hours by Level (Lower = 1000/2000; Upper = 3000/4000) [Based on courses included in the BBA degree]



Between Spring 2012 and Fall 2014 student credit hours increased by 24.2% for lower level BBA courses and 49.6% for upper level BBA courses.

Table 2: One Semester and One Year Changes in SCHs by Level

[Based on historical Fall to Spring patterns, one year changes may be the best way to view trends.]

| | Lower Level | | Upper Level | |
|-------|--------------|----------|--------------|----------|
| | One Semester | One Year | One Semester | One Year |
| F 12 | 9.3% | 6.8% | 4.4% | 8.2% |
| Sp 13 | (2.0%) | 7.2% | 6.1% | 10.7% |
| F 13 | 4.5% | 2.4% | 10.7% | 17.4% |
| Sp 14 | (5.5%) | (1.2%) | 20.1% | 33.0% |
| F 14 | 17.3% | 10.9% | 1.5% | 22.0% |

Figure 22: Student Credit Hours by Location
 [Based on courses that apply to the BBA degree]

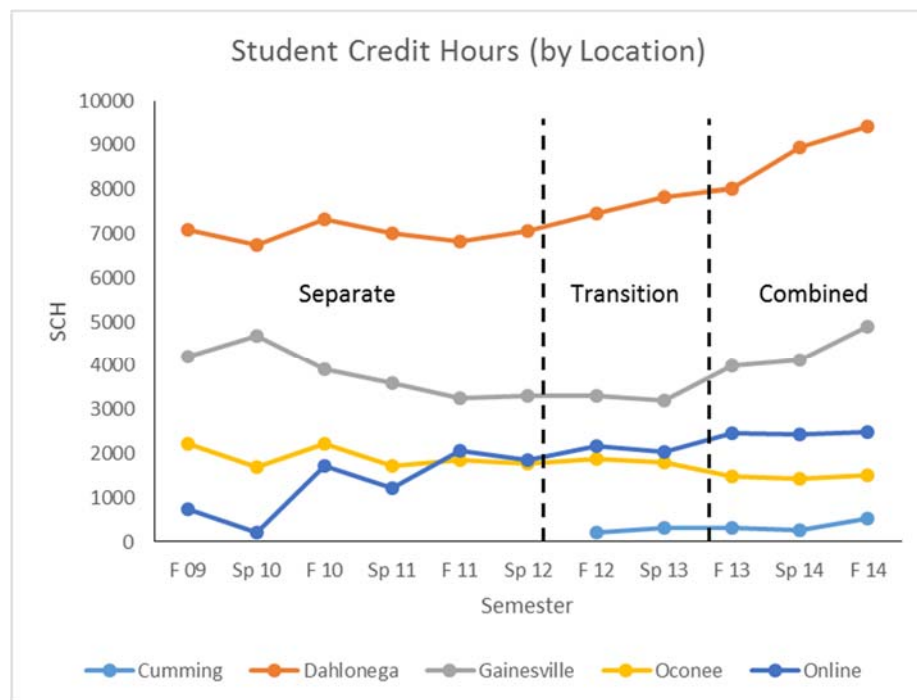


Table 3: Increases by Location

| Location | Sp 12 to F14 Change |
|-------------|---------------------|
| Dahlongega | 33.4% |
| Gainesville | 48.0% |
| Oconee | (14.8%) |
| Online | 33.7% |
| Cumming | new |

Credit hours are based on where the courses were taught (regardless of which faculty taught the course).

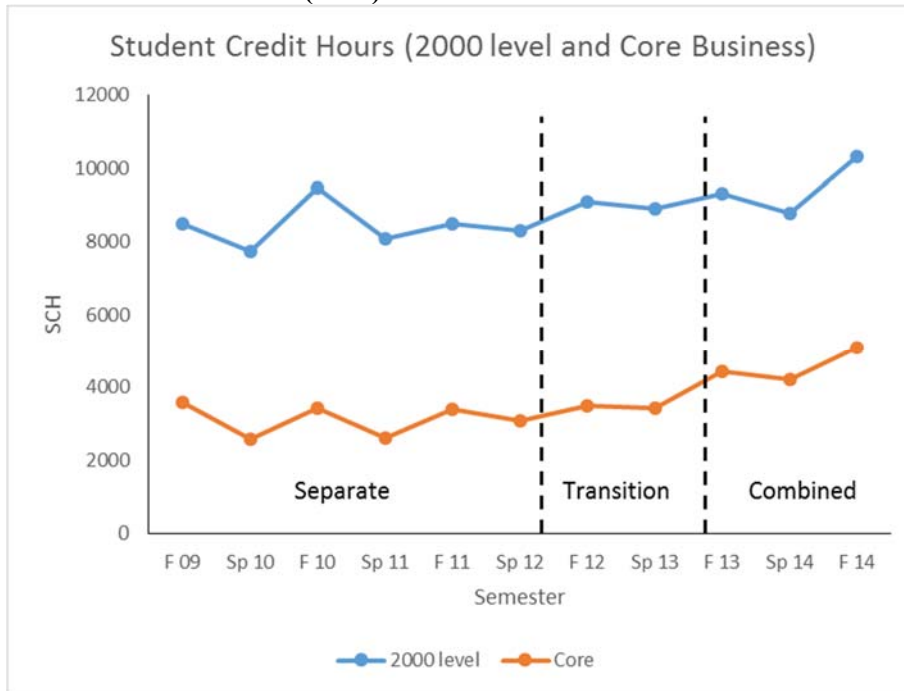
Exploring Enrollment Patterns Tied to Placement in the Curriculum

Beyond the General Education requirements, the BBA curriculum is composed of three major clusters--Foundation Courses, Common Business Core Courses, and Major Specific Courses. Even in non-cohorted programs, groups of students tend to move through the clusters of course together. By looking at historical demand based on placement within the curriculum, the patterns that fit the cluster may serve as good indicators for the courses within the cluster. Or in some cases the patterns may relate to a pair of courses—for example, a two course sequence of sophomore level Accounting may have a fairly level demand across the year (with Accounting 1 high in Fall and Accounting II high in Spring).

All AA in Business and BBA students take the Foundation Courses and all BBA students take the courses in the Common Business Core. As a result, enrollment in these two clusters would be expected to be higher than in the major specific areas. Figure 22 looks at these two clusters. The demand for Foundation Courses and Common Business Core courses show consistent patterns of higher demand in Fall than Spring.

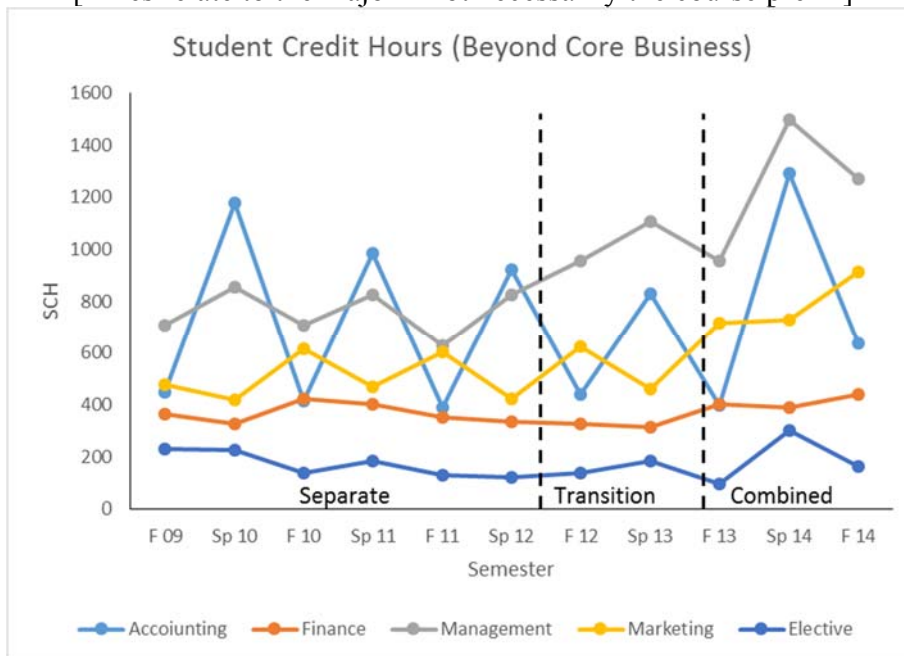
Figure 23 looks at demand in the major specific area where courses were analyzed based on the students who were required to take the course even if the instruction came from a different department in Business. The increase in demand for courses in the Management major cluster of courses is consistent with the increase in the number of Management majors. The alternating highs and lows for the Accounting and Marketing majors reflect the scheduling patterns for courses (where some required courses are Fall only and some are Spring only). The Marketing and Management majors include an additional elective related to the student's career goals, and the credit hours for this course are not reflected in their totals.

Figure 22: BBA Student Credit Hours for Business Courses at the Foundation (2000) Level and in the Business Core



Comparing Fall 2012 to Fall 2014, SCHs for Foundation Courses are up by 13.5% and SCHs for Business Core Courses are up by 46.9%.

Figure 23: BBA Student Credit Hours by Requirements for a Specific Major
[Lines relate to the major – not necessarily the course prefix]



Increases in SCH production in the major specific areas for Fall 2012 to Fall 2014 are 44.2% for Accounting, 36.1% for Finance, 32.9% for Management, and 46.6% for Marketing.

Enrollment Patterns Tied to Teaching Disciplines

Historical demand for instruction provides input into budget requests for additional faculty lines as well as for course scheduling. Figure 24 provides an overview of trends in enrollment for courses grouped by teaching disciplines. The demand pattern breaks into three groups: Accounting/Economics, Management, and the rest. High demand for Accounting and Economics relates to their roles in the Foundation Courses and the existence of the Accounting major. Management represents the largest major and the discipline that has the largest role in the Common Business Core.

Figure 24: Student Credit Hours by Teaching Discipline

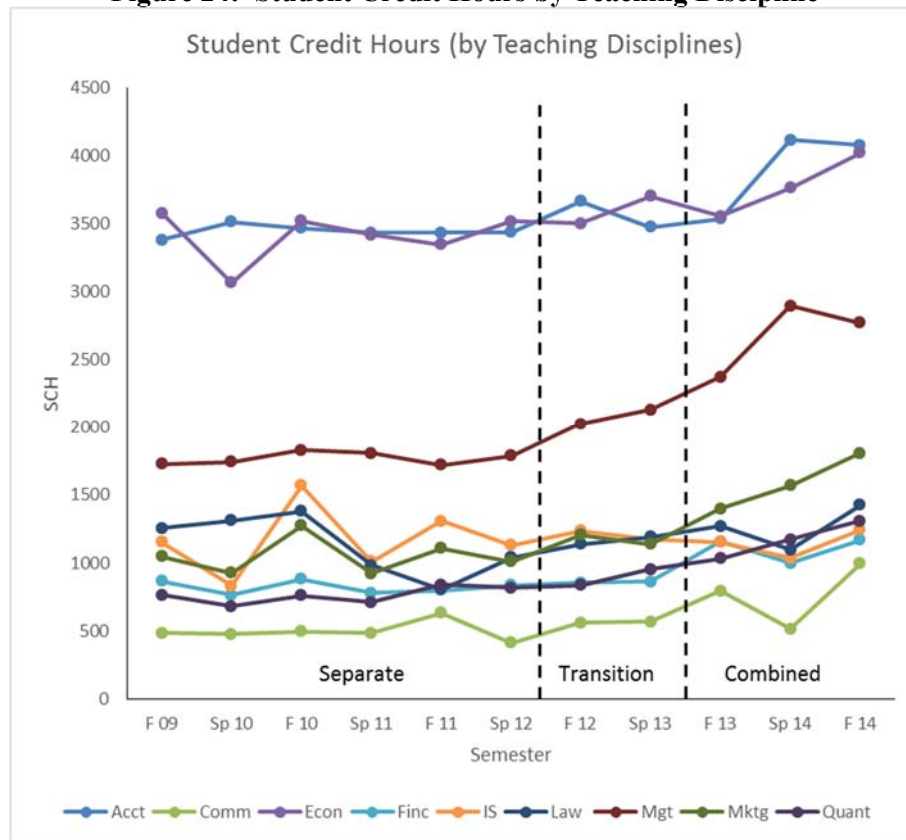


Table 4: Increases in SCHs Based on Teaching Discipline

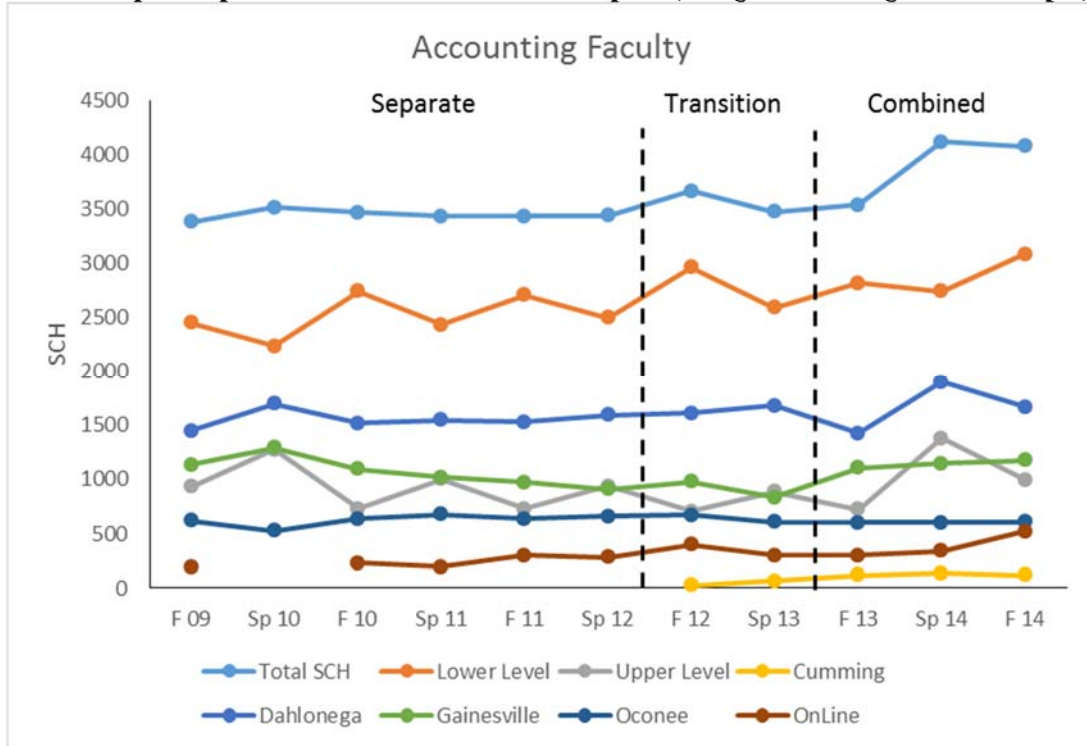
| Teaching Discipline | F12 to F14 Change | Teaching Discipline | F12 to F14 Change |
|-----------------------------|-------------------|---------------------|-------------------|
| Accounting | 11.3% | Law | 25.0% |
| Communications ¹ | 77.5% | Management | 36.9% |
| Economics | 14.8% | Marketing | 50.0% |
| Finance | 36.5% | Quantitative | 56.3% |
| Info. Systems ² | .73% | | |

¹ Communications includes the Business Communications sections taught outside of the College of Business for all terms; but the large increase is heavily influenced by the addition of a new faculty member in Fall 2014 with an additional three sections (between Spring 2012 and Spring 2014, Communications increased by 24.8%).

² Information Systems includes the Area F BUSA 2201 course that Business students take on the Gainesville and Oconee campuses but does not include the CSCI 1250 course taken by Business majors on the Dahlonega campus. CSCI 1250 is omitted from the totals because this course is an option in Area D of the General Education Core requirements for all students and includes a large number of non-Business students.

Figure 25 provides an example of information specific to one teaching discipline. The same type of chart could be made for each teaching discipline. The chart reflects total SCHs provided by the discipline and breaks these down by level of the course and location.

Figure 25: Discipline Specific Student Credit Hour Report (using Accounting as an example)



LIMITATIONS

As with most attempts to study one component of a larger system, some choices were made about where to draw the boundaries for the analysis. Each of these choices has potential impacts on decisions made relative to other programs within the College of Business and to non-BBA programs. Examples include:

- 1) omitting students who are not in the AA Business or the BBA program from any analysis that uses the number of students to estimate credit hour demand could significantly alter the prediction (e.g., Macroeconomics is an option in General Education for all students and many non-Business programs require a limited number of Business courses in their degree);
- 2) omitting other Business programs from the analysis will fail to capture the competing demands for faculty coverage (e.g., the MBA, BAS, CIS, and Paralegal programs);
- 3) omitting courses that are taught in Business but are not required in the BBA degree ignores the need for faculty to support all Business programs and the service function that Business provides (e.g., staffing courses for the MBA and BAS programs and General Education courses that are not required as part of the BBA);
- 4) failing to recognize that the AA program serves as a feeder program to BBA programs at multiple universities could overestimate future demand for upper level courses; and
- 5) omitting changes that are currently “in the works” could impact the reliability of using past data to estimate future demand (e.g., regular periodic reviews of the curriculum and the

approved move of the Information Systems major from a BS program under the Computer Science Department to a major within the BBA)

CONCLUSIONS

Consolidation involves a number of interconnected decisions—some with direct impact on students and others where the impact is indirect. Students feel a direct impact from the program offerings and schedule of courses available. Using data visualization to plan course offerings can help match course availability to demand and help identify changing demands. At the same time, the new university is taking on an identity that builds on the legacy institutions while developing its own unique identity. Too much dependence on historical data could miss the opportunities for growth. Finding the balance between the art and science of decision making with data (visual or otherwise) requires technical knowledge, subject-matter knowledge, patience, and creativity.

APPENDIX

Timeline

| | |
|------|---|
| 1857 | <p>“First Settler” (1857-1964) North Georgia Agricultural College founded (in Dahlonega) Became North Georgia College and later North Georgia College & State University</p> |
| 1964 | <p>“Neighbors” (1964-1984) Gainesville Junior College founded (in Oakwood) Became Gainesville College and later Gainesville State College</p> |
| 1984 | <p>“Friends and Collaborators” (1984-2012) North Georgia College in collaboration with Gainesville Junior College began offering BBA courses on the Oakwood campus as a part-time evening program Gainesville College added a Athens campus (2001); moved to Oconee County (2003) Gainesville State College and North Georgia College & State University received approval from the Board of Regents to jointly add a Forsyth County campus (2011) [6]</p> |
| 2012 | <p>“Engaged” (January 2012-January 2013) in preparation for an arranged marriage University System of Georgia announced the consolidation of the two institutions with a target date for full integration of Fall 2013 [2] Approximately 75 Workgroups addressed consolidation issues [7]</p> |
| 2013 | <p>“Married but not living together” (January 2013-August 2013) University of North Georgia established (January 8) Consolidation was “official” but databases not yet combined Day-to-day operations on the campuses remained separate (admissions, registration, ...) Behind-the-scenes work continued to develop unified processes and merge the database systems</p> |

| | |
|------|--|
| 2013 | <p>“Becoming a Blended Family” (August 2013-present) Struggling with implications of maintaining both the selective admission and the access orientation with different fee structures for the two; balancing faculty and course offerings on four campuses; aligning faculty expectations and salaries; providing consistent communications for all constituents ...</p> |
|------|--|

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CRAFTING A CLINICAL AND ACADEMIC PARTNERSHIP TO IMPROVE PATIENT SAFETY IN AN ACADEMIC MEDICAL CENTER

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ABSTRACT

Annual costs associated with medical errors are estimated at \$17.1 trillion and 210,000 to 400,000 patient deaths. Education in quality and safety management for health professionals did not enter the national agenda until the 2010 Accountable Care Act. No unique academic discipline lays claim to healthcare quality and patient safety bodies of knowledge. The practice field has largely grown through on-the-job training and experiential learning. This paper describes a partnership between clinicians and faculty in an academic medical center to develop an academic program designed specifically to teach quality improvement and patient safety concepts and skills to clinicians and administrators.

BACKGROUND

The annual financial and human costs associated with medical errors are estimated at \$17.1 trillion (Van Den Bos, 2011) and between 210,000 and 400,000 patient deaths (James, 2013). Despite the magnitude of this problem, meaningful data concerning deaths from medical error didn't appear in the scientific and trade literature until the late twentieth century. One of the early major studies in the medical error literature, the Harvard Medical Practice Study (HMPS), resulted in two *JAMA* articles (Brennan et al., 1991; Leape et al., 1991). The HMPS was partially inspired by a study for the California Medical Association (Mills, 1978), that "never had any policy impact" despite its sample size ($n = 20,000$), due to the unpopular finding of a 5% iatrogenic (practitioner-caused) event rate (Wachter, 2005). Although the HMPS data provided the first population estimates of adverse medical events, the study attracted little attention outside the community of medical scholars (Herman, 2000; Millensen, 1997; Kenney, 2008).

The HMPS study defined an adverse event as "an unintended injury ... caused by medical management ... that resulted in measurable disability" (Leape et al., 1991, p. 377), and reported occurrence of such events in 3.7% of all patients. Medical management errors accounted for 58% of the adverse events identified, a number estimated through later study at 69% (Leape, 1994). Leape's 1994 *JAMA* article, "Error in Medicine," which estimated that "180,000 people die each year partly as a result of iatrogenic injury" (p. 1351), is considered a seminal work in the medical

literature, and stimulated additional research in the 1990s, such as the RAND studies (Schuster et al., 1998), that further documented the extent of the healthcare quality problem. However, the major medical error publication event of the decade may have been the December 1999 release of the Institute of Medicine's report, *To Err is Human* (IOM, 2000), which established patient safety as a public policy issue. With its projection of 98,000 deaths attributed to medical errors annually, this report is often credited with “spark[ing] a safety movement” (Wachter, 2009), aimed at reducing preventable medical errors nationally, using a combination of regulation and market incentives.

THE ROLE OF EDUCATION

Although long recognized as important by industry stakeholders, education and training in quality and safety management for health professionals did not enter the national agenda formally until the 2010 Accountable Care Act's provision for “demonstration projects to develop and implement academic curricula that integrates quality improvement and patient safety in the clinical education of health professionals” (US Code, n.d.). Additionally, revisions to accreditation standards for medical schools' core curriculum in 2013, and requirements for integration of quality improvement training in residency programs through the Accreditation Council for Graduate Medical Education standards (ACGME, 2013), were strong drivers for enhancing the knowledge base of physicians.

No academic discipline has laid specific claim to healthcare quality and patient safety bodies of knowledge, although many scholarly disciplines contribute to the body of knowledge supporting organization and system quality improvement. The most prominent ones include cognitive psychology, strategic and operations management, organizational behavior, leadership, quantitative and scientific methods, informatics and data analytics, and biomedical and clinical sciences.

Unfortunately, many physicians, nurses, and other care providers have had minimal exposure to quality and patient safety concepts during or subsequent to their academic training. Few robust academic (i.e., degree-granting) programs have been developed for practicing physicians and other caregivers to teach them how to improve the processes and actions contributing to the quality of healthcare and related services (Karasick & Nash, 2014). Most existing programs are targeted at individuals who have finished their professional training, are not degree granting, and focus on relatively quick acquisition of practical skills and concepts (Thomas et al., 2011).

THE UAB MEDICAL CENTER EXPERIENCE

A cadre of frontline leaders across the enterprise with the requisite knowledge and skills in process management, patient safety, and quality improvement is becoming recognized as an essential core competency for a complex medical center to achieve the desired quality-focused culture. While recent and future medical graduates will benefit from the medical curriculum reforms, a very large segment of the medical workforce, as well as other clinical and administrative professionals, did not receive focused quality and patient safety education needed to be effective in the current environment. Educational intervention on a large scale, and in a relatively short time frame, is needed to build system-wide competency in clinical quality and

patient safety to achieve reliability of desired patient and organizational outcomes. To achieve that goal, the UAB Health System established a partnership with the Department of Health Services Administration (HSA) in the UAB School of Health Professions to develop a graduate-level academic program designed specifically to teach quality improvement and patient safety concepts and skills to physician, nurses, other clinicians, and administrators. One of the key principles underlying the partnership and defining the program was cross-disciplinary collaboration. Faculty, clinicians, and administrators from the Schools of Medicine, Nursing, Public Health, and Business contributed expertise in curriculum design and delivery.

The 15-credit-hour curriculum, structured to develop the knowledge and skills necessary to conduct state-of-the-art clinical practice improvement projects for clinical and non-clinical processes, is delivered in a blended format with approximately 50% of the content delivered online by faculty in the HSA Department. Lecture components are delivered in compressed 2.5-day weekend sessions by faculty and clinicians from the collaborating schools. The curriculum comprises four courses:

- HQS 600 Introduction to Clinical Quality Improvement (4 credits)
- HQS 610 Quantitative Methods, Measurement, and Tools for Quality (4 credits)
- HQS 625 Fundamentals of Patient Safety (4 credits)
- HQS 630 Leadership of High Reliability Organizations (3 credits)

An important component of the program is the applied project, which is integrated into three of the four required courses (HQS 600, 610, 630). The projects, sponsored by the UAB Health System, are assigned to teams of 5 or 6 individuals, selected to ensure a mix of professional backgrounds and personal expertise for fulfilling the team charters. Each team is assigned a mentor/advocate, either a faculty member or a HQS alumnus working in the clinical area sponsoring the project.

This graduate certificate program allows the UAB Health System to support mission-critical professional education for employees in key leadership position while retaining them in their operational roles. To date, 77 students have graduated from the program and 14 projects have been completed or are in second phase investigation. The fourth cohort (26 students) is currently enrolled and pursuing five additional projects.

Only a handful of similar training programs exist nationally, and even fewer offer courses at an educational level that earns academic credit. The certificate program curriculum has been extended by an additional 21 credit hours to constitute a master's degree, scheduled for implementation in fall term 2015. Both full-time and part-time options will be available using a combination of online and blended courses. Additional requirements for the master's degree will include courses in QI models, leadership, data analytics, policy and regulation, and an integrative capstone project. Full-time students can complete the master's degree program in three academic terms.

REFERENCES

Reference citations are available upon request from Donna Slovensky.

GOLF: WHY VARIANCES MATTER ON THE PGA AND LPGA TOURS

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ABSTRACT

The purposes of this research are: (1) to employ simple descriptive statistics to indicate some of the general similarities and differences across the PGA TOUR and LPGA (Ladies Professional Golf Association) for the year 2013, and (2) to use simple tests of hypotheses to determine differences in means and variances across the tours. We find the differences in the variances to be indicative of the degree of competitiveness across tours and those differences explain some of the patterns of winners on the PGA and LPGA tours.

INTRODUCTION

Golf Quotes:

“The object is to put a very small ball into a very tiny and remotely distant hole, with engines singularly ill adapted for the purpose.”¹

“Golf is a good walk spoiled.”²

It is ostensibly the same game—the object is to play the game in the fewest strokes. The rules are the same. Many, but not all aspects of the game are the same. There are also important differences between the world’s most important professional golf tours separated by gender.

The United States is home to the world’s preeminent golf tours for men and women. The PGA TOUR (male touring professionals) and the Ladies Professional Golf Association (LPGA) are the most lucrative and prestigious venues for professional golfers whose vocations are based on competition in a series of tournaments under the aegis of the respective gender-based parent organizations.

The differences and similarities across these tours range from the obvious to the arcane. Much of the prior research has focused on the determinants of success in professional golf. This paper

¹ Often erroneously attributed to Winston Churchill, but first encountered in “Confessions of a Duffer” 1892, *Punch* (London humor magazine), unnamed contributor. See <http://quoteinvestigator.com/2011/08/01/golf-small-hole/>.

² Usually attributed to Mark Twain, also erroneously, but most likely from a 1903 book about lawn tennis actually reading: *“To play golf is to spoil an otherwise enjoyable walk.”* (<http://quoteinvestigator.com/2010/05/28/golf-good-walk/>)

investigates some of those determinants of success, and compares the effects of individual skills on success across these two tours. Some basic evidence is also presented on differences across the tours that are not skill related.

BACKGROUND AND LITERATURE REVIEW

There are several strains of research on professional golf performance based on the statistics compiled by the PGA and LPGA tours. Most of these focus on the proximate determinants of performance. One of the first studies of the statistical determinants of success in professional golf was by Davidson and Templin (1986). Utilizing data from the 1983 PGA (119 of the top 125 money winners) in a multiple regression framework, Davidson and Templin found that greens in regulation (GIR), putting (PPR), and a combined driving efficiency measure were capable of explaining 86% of the variation in scoring average for the PGA tour, with GIR the most important single variable. When the dependent variable was earnings, putting was slightly more important statistically than the other explanatory variables, based on standardized beta coefficients. Shmanske, also using a multiple regression framework for data from the 1986 PGA tour (the top 60 money winners), finds that putting and driving distance are the two most important skills in determining success on the PGA tour. When player money winnings per event are the dependent variable, he finds no significant role for GIR as an explanatory variable. Shmanske also attempts to estimate the greatest payoff for practice, and finds the greatest payoff is for putting practice. Belkin et al. (1994) utilize PGA statistics for three years (1986-88) in correlation and step-wise regression frameworks confirm the importance of GIR and putts per round (PPR) as dominant variables in determining scoring average, with lesser, but statistically important roles for driving distance, driving accuracy and sand saves. They conclude that their research confirms the importance of tour statistics in predicting scoring average.

A 1995 paper by Englehardt concludes that the rankings of the top 10 money winners are not significantly correlated with GIR for 1993 and 94 PGA seasons, and cites an increasingly important role for “total driving,” which is the sum of the ranks in driving distance and driving accuracy. This study utilizes, however, a sample size of only 10. Moy and Liaw (1998) find evidence that conflicts with that from Englehardt for the same PGA year. They find statistically important roles for driving distance, driving accuracy, GIR, and putting in determining earnings on the PGA tour for the 1993 season. The latter study utilizes a multiple regression framework and a much larger sample size than Englehardt. Moy and Liaw’s work also includes analysis of the LPGA and the Senior PGA tours and they offer the general conclusion that a well-rounded game is necessary for success in professional golf. Nero (2001) using data from the 1996 PGA tour finds statistically important roles for driving distance, driving accuracy, putting, and sand saves in determining money won. Interestingly, Nero does not include GIR in his analysis. Nero also estimates a frontier earnings function in an attempt to identify the most efficient golfers—that is those golfers who earn more than that predicted by the regression equation.

Dorsal and Rotunda (2001) using data from the top 42 players on 1990 PGA tour found that GIR was the most important variable determining scoring average, and that driving accuracy was more important than driving distance. Their analysis included simple correlation analysis and multiple

regression techniques. They also used scoring average, top 10 finishes, and money winnings as dependent variables.

Pfizer and Rishel (2005) investigate the determinants of player performance as measured by scoring average and earnings on the United States LPGA (Ladies Professional Golf Association) tour for the 2004 season. Among other findings, this research shows that the percentage of greens reached in regulation and putts per round are by far the most important determinants of both scoring average and earnings on the LPGA tour. They find driving distance and driving accuracy to be equally important factors in success on the LPGA tour.

More recently, Alexander and Kern (2005) offer some evidence that driving distance has become more important over time as a determinant of success on the PGA tour. Callan and Thomas (2007) use a multi-equation approach wherein scoring average is modeled as a function of the normal skill set and earnings are then modeled as a function of scoring average.

In this paper we present evidence in the form of descriptive statistics and simple tests of hypotheses for measures of performance and their determinants.

GENERAL DESCRIPTIONS OF THE TWO TOURS

LPGA

The Ladies Professional Golf Association is arguably the most successful women's professional sports organization in history. It was founded in 1950 and today is best known for a series of weekly tournaments from February to December each year. The LPGA tour is the home for most of the world's best female touring professionals. Though there are other successful national and regional tours for women, the LPGA is without doubt the most lucrative and prestigious.

There are approximately 460 LPGA Tour members with approximately 230 competing during the season. Of the 230 active competitors, 128 (56%) are international players representing 27 different countries (LPGA.COM). For 2014, the LPGA operated 32 official money events for a total of \$56.3 million. The 32 tournaments were held in 13 nations, with 15 of the 32 outside the U.S. Clearly then, though based in the U.S., the LPGA is truly international in scope. Players may qualify for the LPGA tour by finishing high on the Symetra Tour (also run by the LPGA and known as the "road to the LPGA") or through a series of qualifying tournaments.

PGA Tour

Originally a part of the Professional Golfers' Association of America and formerly called the tournament players division, the organizer of the preeminent male golf tour is now known officially as the PGA TOUR. The PGA TOUR is headquartered in Ponte Vedra Beach, Florida. The parent organization actually runs six tours—including the flagship PGA Tour, the Champions Tour, the Web.com Tour, the PGA Tour Canada, PGA Tour Latinoamérica, and the PGA Tour China. Here the focus is on the PGA Tour.

In 2014³, the primary PGA Tour hosted 45 events with total purses of almost \$300 million, excluding FedEx bonus pool money. Of the 45 events, seven were played outside of the U.S. The PGA TOUR kept full statistics for the 2013 season on its website for 180 players. Of those 180, 60 (exactly 1/3) were from nations other than the United States.

Some General Comparisons

Table I provides some general comparisons of these two tours, some of which are described above. Here we generalize the information in the table in comparison form. Several of the statistics may require some amplification.

Table I: General Characteristics across the PGA and LPGA Tours

| Variable | PGA | LPGA |
|--------------------------------|---------------------|---------------------|
| Events 2014 | 45 | 32 |
| Events outside the U.S. | 7 | 15 |
| Prize Money | \$300 million | \$56.3 million |
| Money per Event | \$6.62 million | \$1.76 million |
| Exempt players | 140 (approx.) | 140 (approx.) |
| Sponsor Exemptions | 8 | 2 |
| Full Field | 156 | 144 |
| Cut | low 70 and ties | low 70 and ties |
| Foreign Players | 33% | 56% |
| TV | Golf, ESPN, Network | Golf, ESPN, Network |

First, the PGA plays more tournaments than the LPGA, but fewer outside of the US. Second, the PGA plays for much more prize money. The total amount of “official” money⁴ on the PGA is more than five times that dispersed on the LPGA. On a per event basis, the multiple is nearly four.

The exempt players for the PGA and LPGA tours are an approximation gleaned from the priority rankings that each tour maintains. There are approximately 140 players who are eligible to compete in full-field events on either tour. The PGA priority list begins with PGA Championship and US Open winners, followed by Players Championship, The Masters, The Open Championship, etc. The eighteenth category on the PGA priority list is the top 125 players on the FedEx points list from the prior year. Generally, for full field events players from categories 1-24 can choose to enter full field events (156 players). Individual events on the PGA tour are also allowed 8 sponsor exemptions, some of whom may be amateurs. There are rules governing sponsor exemptions (see category 11 on the PGA Priority Rankings, pgatour.com).

³ Beginning in the 2013-14 season, the last few tournaments (the “Fall series”) are counted as a part of the following year’s season with points allocated for the season ending FedEx Cup.

⁴ There are bonuses paid on each tour for full-year and year-end performances, which are not included in these totals.

For the LPGA, the priority list begins with the top 80 money winners from the previous year, followed by Career Top 20, Major Winners, Tournament Winners, etc. The 9th category is the top ten money winners on the Symetra Tour. The 12th category represents the top 20 from the Q-school. The LPGA, unlike the PGA, continues a Q (qualifying) school for membership on the Tour. Currently, the first 12 categories include 141 LPGA players, so for full-field LPGA events (144 participants) these players can choose to enter. Two sponsor exemptions are permitted for events on the LPGA tour.

Both the PGA and the LPGA have “cut lines” for full-field events. The number of players is reduced after the first two rounds to the low 70 scores plus ties. The PGA tour also has a secondary cut if more than 78 players make the initial cut. The second cut is made after three rounds (54 holes), again to the lowest scoring 70 players plus ties. Players making the cut are then compensated according to their total score for all rounds completed. The PGA and LPGA tours follow similar formulas for the disbursement of purses. The PGA formula is 18% of the total purse for 1st place, 10.8% for 2nd place, 6.8% for 3rd, down to 0.2% for 70th place. The LPGA awards 16% for 1st, 10% for 2nd, 7% for 3rd, down to 0.22% for 70th place. The LPGA reserves approximately 6% of the advertised purse for administrative purposes.

As noted above, the LPGA has a much larger (in absolute or percentage terms) presence of foreign players. It is well-documented (see, for example, Lee, et al. 2012) that the LPGA’s foreign players are most commonly Asian; whereas the PGA’s foreign players are more likely to be European, Australian, and South African.

Television coverage for the LPGA and the PGA is extensive. For the 2014 season, most PGA tournaments were televised on Golf Channel for the first two rounds and “early coverage” on Saturday and Sunday with network (CBS and NBC) broadcasting of the remainder of the weekend golf. Some coverage was also provided by ESPN and TNT. For the LPGA in 2014 most television coverage is provided by Golf Channel, with only the U.S. Women’s Open and the Evian Championship covered by network television. ESPN also provided television coverage of the women’s U.S. and British Opens.

To summarize some important differences based on Table I, the PGA Tour plays for significantly more money than the LPGA, the LPGA has a greater international presence in terms of both participants and event venues, and the PGA tour has significantly greater network television coverage.

DESCRIPTIVE PERFORMANCE STATISTICS

Table II contains some comparative performance statistics for the LPGA and the PGA. Here we choose those common statistics reported by both tours.⁵ The fourth and fifth columns contain t-statistics (corrected for unequal variances) for differences in means and F-statistics for differences in variances, respectively.

⁵ For example, the PGA Tour reports a “strokes gained” statistic that the LPGA does not. The PGA Tour also reports a scoring average that adjusted for the field scores—indicating the difficulty of the course(s) for a given tournament. The PGA Tour scoring average reported in the table is unadjusted.

The general form of the hypothesis tests for means is:

$$H_0: \mu_{lpga} = \mu_{pga} \text{ (the means do not differ across the tours)}$$

$$H_1: \mu_{lpga} \neq \mu_{pga} \text{ (the means differ across the tours)}$$

The general form of the hypothesis tests for variances is:

$$H_0: \sigma_{lpga}^2 = \sigma_{pga}^2 \text{ (the variances do not differ across the tours)}$$

$$H_1: \sigma_{lpga}^2 \neq \sigma_{pga}^2 \text{ (the variances differ across the tours)}$$

Means

For scoring average, the LPGA scores are almost exactly one and one-half strokes higher per round than those of the PGA (recall that the PGA scores utilized here are unadjusted for course difficulty). That difference is obviously both statistically and practically different. Players on both tours have GIR percentages of approximately 65%. The LPGA GIR statistic is slightly higher, but that difference is not statistically significant.

Table II: Performance Statistics across Players, Tours, for the 2013 Seasons

| Statistic | LPGA Means (std. dev.) | PGA Means (std. dev.) | t-statistic | F-statistic |
|-----------------------|---------------------------------|-------------------------------------|-------------------|-------------------|
| Scoring Average | 72.58 (1.29) | 71.07 (0.59) | +13.13* | 4.78* |
| Greens in Regulation | 65.50 (5.25) | 64.99 (2.52) | +1.15 | 4.34* |
| Driving Accuracy | 70.50 (7.47) | 61.29 (4.75) | +14.50* | 2.47* |
| Driving Distance | 247.50 (9.50) | 287.92 (8.01) | -13.54* | 1.41** |
| Percentage Sand Saves | 44.87 (8.24) | 50.56 (6.81) | -41.74* | 1.46* |
| Putts per Round | 30.16 (0.66) | 29.19 (0.55) | +6.83* | 1.44* |
| Putts per GIR | 1.83 (0.0369) | 1.78 (0.028) | +14.78* | 1.70* |
| Money Winnings | \$293,726 (\$414,412) | \$1,347,314 (\$1,290,103) | -10.32* | 3.11* |
| Observations | n = 147 | n = 180 | $t_{crit} = 1.97$ | $F_{crit} = 1.30$ |

(Means are in **bold**, standard deviations in parentheses, * indicates statistical significance at $\alpha < 0.01$, ** indicates statistical significance at $\alpha < 0.05$. the critical values of t and F are given for $\alpha = 0.05$, signs for the t-statistics reflect $\bar{x}_{lpga} - \bar{x}_{pga}$)

For the driving statistics, it is well-known that the PGA members drive the golf ball much farther on average than do LPGA members. It is perhaps less well-known to the casual observer that players on the LPGA have significantly higher proportions of drives in the fairway (driving accuracy).

PGA golfers manage 2 or fewer strokes to complete a hole from greenside bunkers (sand saves) a little over 50% of the opportunities; whereas LPGA players manage to save par (or better) in approximately 45% of opportunities. That difference is statistically significant.

Considering putting, PGA players average 1 fewer stroke per round than do the LPGA golfers and that difference is statistically significant. Recall that the LPGA generally has a higher GIR statistic, and these variables are positively related—due to more one-putt greens for missed greens in regulation.

Finally, the mean winnings for the PGA tour across 180 players was \$1.35 million for 2013 compared to \$294,000 for the top 147 players on the LPGA for the same year.

Variations

The fifth column in Table II contains F-statistics, a test for differences in the variances for the eight categories in the table. We believe these tests have important implications for the tours in terms of who might win a tournament, the distribution of money winnings, and player rankings.

The standard deviation and its square (the variance) are measures of dispersion—that is, they measure the degree to which individual observations vary from the mean. These can also be interpreted as indicators of the level of competition—here across players on a given tour. Consider the standard deviations for scoring average. On the PGA Tour, the standard deviation in scoring average across players is 0.59 strokes per round. The corresponding statistic for the LPGA is 1.29. The F-test for this variable is simply:

$$F = \frac{s_{lpga}^2}{s_{pga}^2} = \frac{1.29^2}{0.59^2} = 4.78.$$

This indicates that the variance in scoring average across players on the LPGA tour is almost five times that on the PGA Tour. (A better measure for descriptive comparison, would be to compare standard deviations—by that measure the dispersion in scoring average is a little more than twice as high on the LPGA tour.) The calculated value of F far exceeds the critical value ($F_{crit} = 1.30$), so the variance for the LPGA is statistically and practically larger than that on the PGA Tour. In terms of outcomes, the practical significance of this finding is this: if the 200th (or even higher) ranked PGA Tour player has a particularly good week, he has a very good chance of winning the tournament. The correspondingly ranked female on the LPGA has little or no chance of winning on a week-to-week basis. The evidence of this is compelling. There were seven winners on the PGA Tour in 2013 whose ranks were 200 or higher in the Official World Golf Rankings, including Derek Ernst ranked at 1,207 and Woody Austin ranked 608. No LPGA tournament was won by a golfer ranked over 100 (Jennifer Johnson was ranked 87th on the Rolex Women's World Golf

Rankings when she won the Mobile Bay LPGA Classic). This effect is not new and it has continued into 2014. In 2014 there were five winners on the PGA Tour with rankings over 200 and another eight winners with rankings over 100. No LPGA winner had a rank over 100. Mo Martin was ranked 99th when she won the British Open and Austin Ernst was ranked 69th when she won the Portland Classic. No winner on the LPGA was ranked over 100 in 2014.

Note that in every case, with the exception of money winnings, the variance for the individual categories is statistically greater across the LPGA players than the PGA players. Generally then, there is greater dispersion across LPGA players than PGA players for greens in regulation, driving distance, driving accuracy, sand saves, and both reported measures of putting efficiency. The dispersion of money winnings is greater on the PGA Tour, but that's because the mean earnings are so much greater. For this measure a better comparative statistic is likely the coefficient of variation⁶ (CV) which measures the standard deviation relative to the mean. Here the corresponding measures equal 140.8% for the LPGA and 95.8% for the PGA. That indicates that the relative dispersion is more unequal on the LPGA tour.

To summarize the variance evidence from Table II, the dispersion in performance statistics is greater on the LPGA than the PGA. The greater dispersion in skills across LPGA players is undoubtedly related to the greater dispersion in scoring average and the greater *relative* dispersion in money winnings.

CONCLUSIONS

The findings above indicate that there are important statistical differences in means of performance related variables as compared for the LPGA and PGA tours. Most of these are well-known for observers familiar with these two tours. We do not find these differences surprising in any particular way. We do find the differences in variances to be interesting and we argue they have important implications regarding the levels of competition across tours and the likelihood of winners from given ranks on the respective tours. Specifically we find that lower ranked players on the PGA tour win with common frequency, whereas winners on the LPGA tour generally are from top ranked players.

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⁶ $CV = \frac{s}{\bar{x}} \cdot 100\%$

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A TAXONOMY OF ANDROID VULNERABILITIES

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ABSTRACT

Mobile devices are an essential part of our personal, social, and business communications. The subject of intensive research and development, mobile devices are becoming increasingly powerful and sophisticated. The growth of mobile computing allows for new concepts and applications. As primary connectivity and communication points, mobile devices contain troves personal and business information. Unfortunately, they also present a rich target for attackers. The quantity and variety of mobile device threats are rapidly expanding. To simplify threat analysis, this research develops a taxonomy of vulnerabilities for the Android operating system. The taxonomy analyzes vulnerabilities according to five factors: attack type, ingress vector, loss of data confidentiality, loss of onboard data integrity, and attacker incentive. The framework is designed to guide system managers in decision making. Besides developing the taxonomy and populating it with recent examples of malware, this research also reviews the Android operating system, provides recommendations for management, and suggests future research directions.

Keywords: Mobile devices; Android; malware, security

INTRODUCTION

In the era of hyper-connectivity, mobile computing is the platform of choice. Last year, the internet landscape changed when mobile device internet usage surpassed PC usage. According to a recent survey, American adults spend more time using their mobile devices than their desktop and laptop computers (Vidas *et. al.*, 2011). The rapid, cross-cultural diffusion of mobile computing is due in part to improved handsets, pervasive wireless connectivity, and more sophisticated software (Dunklin, 2013). More and more adopters are using their devices for a combination of business, personal, and social applications. This is underscored by a prevailing business trend which encourages users to bring their own devices (BYOD) to access corporate networks and information services.

The average mobile device contains a cocktail of confidential and sensitive information. Consequently, the theft of this information rich represents a primary goal for hackers worldwide. Fortunately, mobile device manufacturers have noted this activity and taken proactive steps to curtail attackers. They have

responded with a variety of tools and options. Collectively, these revisions have made it harder for attackers to compromise mobile devices. However, as quickly as the manufacturers release patches and new security features the attackers identify new vulnerabilities and security workarounds.

The first step in improving mobile device integrity is identifying and interpreting threats. In this regard, the purpose of the present study is to devise a system for classifying and assessing mobile operating system vulnerabilities. Specifically, this research focuses on malware which targets the Android operating system. The Android operating system is the most widely used mobile operating system. It is not only employed in smartphone but also sees use within surface devices and tablets. Given its wide distribution, Android is vulnerable to a range of malicious software; numerous viruses, worms, trojans, and rootkits have been released for the Android environment in recent months. The malware targets different vulnerabilities within the operating system. It exploits various weaknesses for different goals. To better understand the threat to corporate resources, this research develops a taxonomy to assist in interpretation. The taxonomy identifies and analyzes Android vulnerabilities according to their most critical attributes. Specifically, they categories include attack type, ingress vector, loss of data confidentiality, loss of onboard data integrity, and attacker incentive. The benefits of using the taxonomy include:

- Reduced risks to organizations and individuals
- Better opportunities to educate the public
- Increased viability of BYOD workplace architectures.
- Increased risk awareness among mobile application developers
- Future business opportunities
- Identification of new trends in mobile security

By understanding mobile device security risks, business managers and end users will be able to prepare themselves and implement appropriate safeguards. Thus, a clear, salient taxonomy will be of significant utility to a large swath of mobile device adopters. The remainder of this article is organized as follows: section two provides background information. Section three presents the Android operating system. Section four describes the conceptual development and provides an explanation of the five taxonomy attributes. Section five interprets recent instances of Android vulnerabilities and inserts samples into the taxonomy. Section six provides recommendations for systems administrators. These suggestions focus on protecting organizational data. Finally, section seven gives concluding comments and points to future research.

BACKGROUND

A number of previous studies have investigated various aspects of mobile device malware. For instance, Felt *et. al.* (2011) studied the incentives behind approximately 50 samples of iOS and Android malware which were active between 2009 and 2011. The incentives considered in the study included novelty and amusement, selling user information, stealing user credentials, premium rate calls and SMS, SMS spam, search engine optimization, and ransom. Some of the future incentives that were identified include clickstream advertising fraud, invasive advertising, government control, email-spam, in-application billing fraud, distributed denial of service attacks, and NFC and credit cards. This study also used the data set to evaluate the effectiveness of techniques for preventing and identifying malware. Interestingly, it was found that attackers are quicker to release malware for android devices while malware targeted at the Apple iOS operating system enjoys a longer period of activity before patches are released.

Another study focused on privilege escalation attacks within the Android ecosystem (Davi *et. al.*, 2011). This research focused on the vulnerabilities which allow rootkits and trojans to flourish. It showed that despite strict boundaries on software execution and restrictions to user space, privilege escalation is possible using a number of ingress vectors. The investigation found that basic methods such as exploitation of legitimate applications during runtime can be used to gain root permissions. Further, transitive permission usage attacks can be successful despite security features such as discretionary access

control, sandboxing, permission restriction, component escalation, and application signing. This study concludes that Android's sandbox model fails as a last resort against malware and sophisticated runtime attacks.

A separate research project correlated the Android attack surface with identifying recent malware releases (Vidas *et al.*, 2011). Some 36 vulnerabilities were identified. This research began by identifying relevant components of the android security model: application handling, patch cycles, trusted USB connections, recovery mode and boot process, and uniform privilege separation. For each control, potential weaknesses were uncovered. Based on these vulnerabilities several attack classes were developed. The classes include: attacks with no physical access, physical attacks with and without the Android Developers Bridge disabled, unprivileged attacks, and remote exploitation attacks. It was noted that in all but 1 of the 36 observed vulnerabilities, the purpose was to gain root privileges, allowing complete loss of integrity and confidentiality.

Zhou and Jiang (2012) identified more than 1,200 malware samples which were active between 2010 and 2011. They analyzed malicious software according to the ways in which it is installed and the manner in which it is activated. In terms of installation, malware was classified as installed as repackaging of a legitimate app, an update, a drive-by download, or standalone malware. Activation types include boot, SMS, network, call, usb, packaging, battery, system, and operating system. For further assessment, the table was extended to include each program's path to privilege escalation. Within this category, each instance was categorized as Exploit, RATC, Ginger Break, Asroot, or encryption. In addition, the type of remote access (network or SMS-based) was included. Finally, the purpose of each malware was analyzed. Financial charges such as phone calls, premium SMS messages, and block SMS were included as potential theft points.

ANDROID OPERATING SYSTEM

Linux is a popular open source operating system that has been ported to numerous devices, powering everything from servers to robots to the International Space Station. Since Android's inception it has been built on some variation of the Linux core code, or kernel. Originally built on the 2.6 version of the Linux kernel, Android has since moved on to the 3.x branch of the kernel (Brady, 2008). The kernel provides basic input and output for the system, acting as a go between for the applications and the hardware. The original versions of Android bear little resemblance to any of the modern iterations, however rapid innovation has led to rapid adoption and a requisite explosion in market share. Market research firm Gartner shows the success of the OHS's vision with a total install base of almost 2 billion devices, Android is the top of the heap in terms of adoption for mobile devices. The closest competitor, iOS lays claim to a mere 684 million.

The Linux kernel is organized in several layers and attempts to segregate user processes, operating on the "principle of least privilege." Just like Linux, there are several layers to the Android software stack, these consist of the linux kernel, the native library layer, the application framework layer, and the applications layer.

Despite the modern Android system implementing an architecture similar to Linux, there are several additional features that set it apart from Linux. The important distinction is that Android is built on the Linux kernel, but this does not make Android a Linux variant. Android is designed to work on a much wider array of hardware than is typical for most Linux systems, including having been unofficially ported to x86 and MIPS processors. Android powers a wide range of devices, from embedded systems to mobile devices, ranging in screen size from 12 inches on select tablets all the way down to wearables with 2 inch screens. This extreme variation in form factor and physical features of the devices necessitates a different approach than what Linux employs to communicating with hardware assets. To address this, Android

includes a Hardware Abstraction Layer that developers of new hardware must include/modify to address their specific hardware components. The general overview of the Android architecture is detailed side by side with Linux in figure 1.

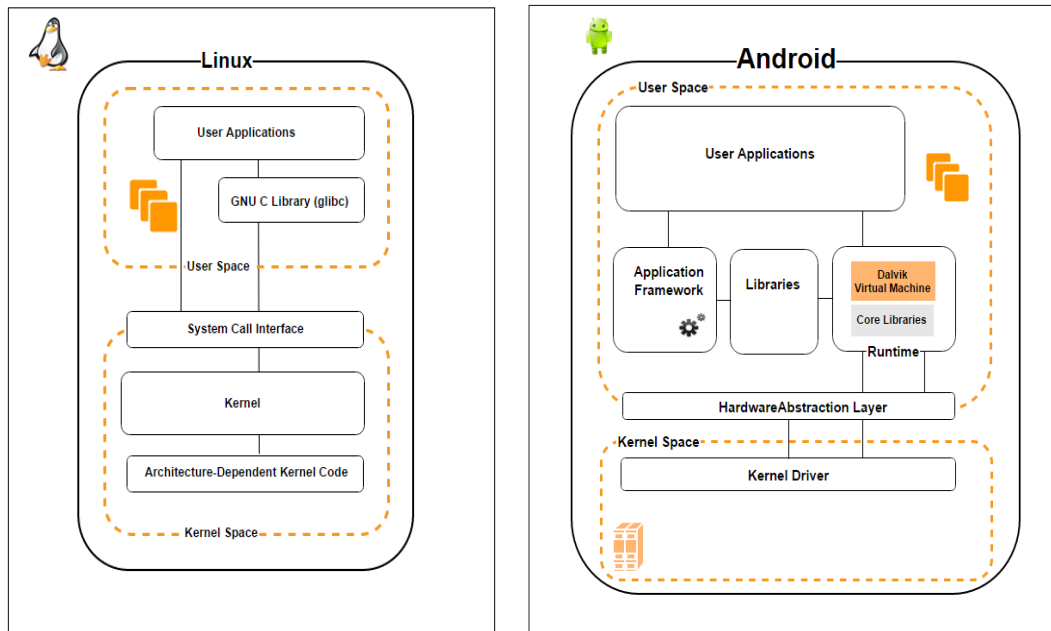


Figure 1: Android System Architecture vs Linux System Architecture

All applications within Android run under the Dalvik Virtual Machine (DVM), a sandboxing strategy that allows code to run in its own virtual machine. This will soon be replaced with a new runtime environment but the same strategy persists. Ultimately, this prevents one application from accessing the data of another. This approach to securing the system necessitates an approach whereby the system is compromised on a fairly low level. To consider compromising the system on a lower level we need to look at the Bootloader and the first process spawned by it, the init process. Typically bootloaders are vendor specific and are locked as well as cryptographically signed, in an attempt to prevent modified bootloaders from being utilized by advanced users, as well as bootloaders being modified by malicious actors. Despite its improvement over contemporary projects, this is not a foolproof process.

CONCEPTUAL DEVELOPMENT

Following a careful analysis of the Android operating system and considering the needs of information executives, it was determined that a five attribute taxonomy of mobile device vulnerabilities should be created. The categories were developed following literature review, informal conversations with chief information officers, and analysis of contemporary mobile OS vulnerabilities. After several rounds of revision, the following categories are proposed: attack type, ingress vector, loss of data confidentiality, loss of onboard data integrity, and attacker incentive. The five categories are described in more detail in the following paragraphs.

Attack type: Surprisingly, a number of different exploits already exist in the mobile ecosystem. The purpose of the first category is to classify them according to their general objective. These have been summarized into a set of values which include denial of service, bypass feature, execute arbitrary code, memory corruption, gain information, escalate privileges, and memory overflow. The attack type may also coincide with the purpose or the incentive behind the attack. For example, the denial of Service

vulnerability is often times the means and the goal of the attacker. A converse example would be a buffer overflow vulnerability, as the overflow is not the ultimate goal of the attacker but a conduit to executing arbitrary code to further some other goal.

Ingress vector: Besides understanding the purpose of each attack, decision makers must appreciate how each vulnerability is initially exploited. This is summarized in terms of a second attribute called ingress vector. The ingress vector is the point through which a device is initially compromised. This point could be local or remote. The differences have implications for network managers. Local attacks are easier to prevent than remote attacks, although remote attackers can be detected over the network. An exploit requiring a local access vector is more difficult to pull off as it requires a local user to conduct the attack or a remote access user with shell access.

Loss of data confidentiality: The loss of data confidentiality implies that data has been shared with unauthorized parties. One of the central tenants of organizational computing is the assumption of enterprise data confidentiality. All mobile devices contain sensitive data such as contact information, phone records, text messages, browsing habits, corporate files and resources, onboard email accounts, and proprietary records. A breach of data confidentiality could be potentially catastrophic. This category is included in the taxonomy because managers must assess the likelihood of this risk and create response plans for coping with inevitable confidentiality breaches.

Loss of Integrity: The loss of integrity means that data has been subjected to unauthorized modifications. The extent of the damage can vary. A loss of integrity could be confined to local data on a single user's device or it could have implications for all users of cloud-hosted resources. Attacks which corrupt enterprise data are often associated with hacktivism or efforts to sabotage corporate operations. Understanding the scope of integrity loss is useful when planning mitigations.

Attacker Incentive: It is also important for managers to understand attackers' motivations. The purpose of an attack could be to steal data, allow arbitrary code execution in the future, achieve denial of service, or pursue some other agenda. Attack response should be based on the goal of the attacker. Attackers interested in achieving notoriety could simply be handed off to law enforcement officials while international efforts to take out a competitor must be addressed more carefully. It should be noted that this classification is difficult because most databases do not provide sufficient information to reach positive conclusions.

TAXONOMY

For a sample implementation of the proposed taxonomy, the vulnerabilities listed in the National Vulnerabilities Database and in the Android Open Source Project Issue Tracker were analyzed. The National Vulnerabilities Database (NVDB) is a collection of software vulnerabilities that are cultivated by the National Institute of Standards and Technology (NIST). The NIST is an agency subordinate to the US Dept. of Commerce. The Android Open Source Project (AOSP) maintains a publicly accessible database of bugs in the Android platform, as well as a general issue tracker and feature request platform. When the AOSP resolves a bug, the fix is incorporated into a future Android release. For various business reasons, not all known vulnerabilities are disclosed in a timely fashion in the AOSP repository. Likewise the NIST data has its own shortcomings; the technical merits of the NIST database are not always to the same standard as the AOSP database. Thus, the NVDB and the AOSP were together determined to be the best sources for this illustration. Further they provide an excellent overview of the most relevant IA threats to Android. The taxonomy is illustrated in Table 1 (below).

| CVE ID | Attack Type | Ingress Vector | Loss of Data Confidentiality | Loss of Integrity | Attacker Incentive |
|---------------|---|----------------|------------------------------|-------------------|-----------------------|
| CVE-2014-3153 | Permissions, Privileges, and Access Control | Local | Complete | Complete | Any |
| CVE-2014-3100 | Exec Code Overflow Bypass +Info | Remote | Partial | Partial | Any |
| CVE-2014-1939 | Exec Code | Remote | Partial | Partial | Any |
| CVE-2014-0196 | Race Condition | Local | Complete | Complete | Any |
| CVE-2013-7373 | Info | Remote | Partial | Partial | Any |
| CVE-2013-7372 | Bypass | Remote | None | Partial | Any |
| CVE-2013-6770 | Privileges | Remote | Complete | Complete | Any |
| CVE-2013-6282 | Memory Overread | Remote | Partial | Partial | Financial Gain |
| CVE-2013-6271 | Bypass | Remote | Complete | Complete | Information Gathering |
| CVE-2013-5933 | DoS Overflow +Priv Mem. Corr. | Local | Complete | Complete | Any |
| CVE-2013-4787 | Exec Code | Remote | Complete | Complete | Any |
| CVE-2013-4777 | Privileges | Local | Complete | Complete | Any |
| CVE-2013-4738 | Buffer Overflow | Remote | Partial | Partial | Information Gathering |
| CVE-2013-4710 | DoS | Remote | Complete | Complete | Any |
| CVE-2013-3666 | Exec Code | Local | Complete | Complete | Any |
| CVE-2013-2596 | Privileges | Remote | Complete | Complete | Any |
| CVE-2012-4221 | DoS Exec Code Overflow | Remote | Partial | Partial | Any |
| CVE-2012-4220 | DoS Exec Code | Remote | Partial | Partial | Any |
| CVE-2012-3979 | Exec Code | Remote | Partial | Partial | Any |
| #9950697 | Permissions, Privileges, and Access Control | Local | Complete | Complete | Any |
| #9695860 | Permissions, Privileges, and Access Control | Local | Complete | Complete | Any |

Table 1: Android Vulnerability Sampling

As indicated in the table above, there is significant variation in attack type. Code execution, denial of service, and privilege escalation are the most common approaches. The next category, ingress vector, indicates that the majority of vulnerabilities are exploited remotely. The third category, loss of data confidentiality, records the degree to which a vulnerability leads to the compromise of mobile device onboard data. From the sample it appears that complete loss of data confidentiality is most prevalent. The following attribute is loss of integrity. This includes both system and data integrity. Here again, complete loss of integrity is most common. Finally, the taxonomy records the incentive to perform the attack. Because the majority of vulnerabilities are a means to a further end, they do not directly lead to material gains. Thus, it is difficult to determine attacker incentive from the limited information.

RECOMMENDATIONS FOR SYSTEMS MANAGERS

The threat of mobile device malware should be of serious concern to information systems managers. It must be accepted that security breaches are unavoidable. Instead of assuming that traditional defenses are sufficient (e.g. passwords, network firewalls, anti-virus software) forward-thinking systems administrators should create implementable contingency plans. In preparation for inevitable security incidents, the following recommendations are proffered:

- Systems managers should engage users in conversations about mobile device security. For those working in technical positions, it is easy to assume that employees are aware of the latest security threats. Unfortunately, this is rarely the case. Users should be able to discern between benign and malicious games and apps. They should be sensitive to the sources from which they are downloading software. Finally, they should be able to interpret system warnings which flash when certain software is installed.

- Before implementing a BYOD (bring your own device) architecture, some thought must be given to the policies which will govern mobile device access. The system administrator will need to control a variety of different user-owned and managed devices. These platforms will be used to access the corporate network, interact with servers, and access secure information. The plan should also address logging, device identification, user management, and session management.
- Ensure that mobile device operating systems are fully patched and are up to date. Within the Android ecosystem, system updates can be blocked by users, manufacturers, or internet service providers. Unpatched mobile devices are easy targets for attackers since they are vulnerable to known exploits. In some cases, device users must be convinced that allowing their device to update is essential part of organizational security.
- Implement device encryption. The latest generation of Android is equipped with powerful encryption systems. This security feature will protect data stored on lost or missing devices. The encryption system requires a password. Systems administrators should ensure that device users are using difficult passwords. Even though encryption won't protect a device from malicious software, this recommendation was included because devices are lost as often as they are compromised with malware.
- Prevent Rooting. Rooting is the process of the End User gaining Root Privileges, which allow the removal of security limitations on a device so that a user can install unauthorized software or unlock disabled features. A mobile device which has been unlocked is at an increased risk of being compromised. The vendor imposed security limitations are not being implemented on an unlocked device. This means that malicious software, packaged with benign content, can extract itself and take over the kernel without any resistance.

Beyond these recommendations, a number of additional suggestions should be considered. For instance, users should be instructed to only install apps from a trusted source. It may be beneficial to build an enterprise apps store which is populated with trusted software. As a benefit, it will be easier to push updates to client devices. Another deterrent is two-factor authentication. Although most operating systems allow users to authenticate with just a username and password, mobile operating systems can be configured with additional security challenges. For instance, the Android platform also accepts fingerprint identification. It is more difficult for malware to overcome biometric checks. Finally, some malware is introduced via the cloud. To extend their storage capabilities, many mobile device users rely on public clouds for storage and back-ups. As public spaces, these clouds are occasionally compromised by attackers and injected with malware. To avoid malicious software, it may be prudent to set up a private mobile cloud and grant access to corporate device users.

CONCLUSIONS

Organizations and individuals have come to rely on mobile devices for a variety of business and personal functions. In the era of ubiquitous, high-speed wireless connectivity, mobile devices are entrusted with a rich mixture of personal and professional information. This data makes a prime target for attackers. Personal identification information, bank accounts, work information, email, business contacts, and personal files are all accessible from with the average smartphone. Because mobile devices are a priority target among attackers, manufacturers have taken steps to ensure that the latest generation of handsets has more security features than ever. Unfortunately, these precautions are not enough. As quickly as manufacturers can develop patches, attackers find new vulnerabilities. To assist in the analysis of new vulnerabilities, this research developed a taxonomic structure. This new framework categorizes vulnerabilities along multiple features. The categories include: attack type, ingress vector, loss of data confidentiality, loss of onboard data integrity, and attacker incentive. Besides proposing the taxonomy, this research samples 20 recent Android vulnerabilities. It also provides recommendations for managers. Future research should focus on integrating independent systems for interrogating mobile devices to identify malicious software.

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ReviewMap: An Exploratory Text Mining System for Competitive Analysis Using Online Reviews

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ABSTRACT

What is our greatest perceived strength? And how important is that feature to our competitors' customers? To answer such questions, we introduce ReviewMap, a text mining/visualization system for competitive analysis using online reviews. ReviewMap transforms an archive of reviews spanning multiple suppliers into a hierarchy of data of increasing dimensionality. Visual summaries at each level are integrated to propagate selections at one level throughout the rest of the hierarchy. Our design enables analysts to identify features required for competition at a given level and features that currently discriminate amongst competitors. This intelligence can be used to plan competitive actions, anticipate rivals' actions and find opportunities in changing and/or less competitive spaces.

1. INTRODUCTION

Online review sites such as TripAdvisor provide consumers with unprecedented power to 1) find products and services that meet specific needs and 2) provide feedback to suppliers. Our concern in this paper is with the online review site as a feedback channel. It is common to see suppliers respond to individual reviews in an effort to reinforce positive experiences or make amends for bad ones. In this paper, we expand the suppliers' sights beyond their own reviews to those of the competition, our goal being to use the online review archive as a source of competitive intelligence.

Accessing reviews for competitive intelligence through a review site's interface is impractical since such interfaces are designed for manual processing of one supplier at a time. A competitive analysis must come from an automated system that relies upon text mining tools to summarize an archive of reviews spanning multiple suppliers and to identify relationships. Modern visualization technologies are also required to present results in meaningful ways.

The term *social media analytics* is often used to describe the tasks and technologies listed above, and several carefully-crafted models of social media analytics have been published recently [Zeng, et al, 2010; Fan & Gordon, 2014]. In this paper, we show the design and application of ReviewMap, an integrated text mining and visualization system that is consistent with [Fan & Gordon, 2014]. The ReviewMap experiences presented here provide a basis for evaluating

- the capabilities of text mining tools to support realistic analyses and
- the requirements these tools demand of the user.

The paper is organized as follows. In section 2, we begin with a short description of the TripAdvisor hotel review site, and describe how we use a publically available data set of TripAdvisor reviews [Wang, 2010]. We present a review of the social media analytics literature, concentrating on analytics for competitive intelligence, in Section 3. This review provides us with a target to pursue in our system development efforts. In sections 4 and 5, we select a set of text mining and visualization techniques that have been shown to be effective for the target uncovered in Section 3. In Section 6, we integrate the chosen tools and apply the result to a sample from [Wang, 2010] for three New York City hotels, and conclude with a discussion of our results, our design choices and future work in Section 7.

2. TripAdvisor DATA

TripAdvisor (www.tripadvisor.com) is the world's largest travel site. The TripAdvisor archive contains over 150 million reviews, many with traveler-supplied photos, of hotels, restaurants and attractions. Hotel reviews consist of a free-form text portion and a 1-to-5 numeric rating section for location, sleep quality, rooms, service, value, cleanliness and overall.

[Wang, 2010] presents a data set of 235,793 reviews collected from TripAdvisor in late winter, 2009. The data set contains both the free-form text and the 1-to-5 numeric ratings. At the time of data collection, numeric ratings were collected for value, room, location, cleanliness, check in/front desk, service, business service and overall.

In this paper, we use a sample of 1,040 reviews for three hotels located in midtown Manhattan: Belluno, Firenze and Venezia (pseudonyms). At the time of this writing, these hotels rank between the 17th and 21st percentiles out of 452 New York City hotels. The Firenze and Venezia are head-to-head competitors for the high-end visitor, while the Belluno caters to a more cost-conscious clientele. At the time of this writing, a single, mid-week night, with 60-day advance booking, costs \$365, \$579 and \$629 respectively. We chose these hotels to test the reviews' ability to discriminate amongst closely-ranked players in the same and different sectors of the competitive landscape.

3. SOCIAL MEDIA ANALYTICS

[Fan & Gordon, 2014] present social media analytics as a three-stage process: *capture*, *understand and present*. In this paper, we are concerned with the *understand* phase, which involves modeling the captured data and gaining insights from these models, and the *present* stage, which deals with displaying findings from the *understand* stage using visual analytics.

The competitive analysis we use in this paper is customer segmentation, which is usually discussed in terms of variables such as benefits sought, product feature preference, product usage and price sensitivity [D'Aveni, 2007]. The objective of our modeling and presentations is to develop a deep understanding of customers' tastes and buying behavior to create better customer segmentation. Segmentation assists businesses in reaching various groups, using the differences

to guide different strategies for increasing brand engagement for each group [Fan & Gordon, 2014]. Since the success of these strategies depends on the value that customers place on features [D'Aveni, 2007], we designed ReviewMap to draw up a list of the features offered by the different brands in the market and gather data on how customers perceive those features.

[Marchionini, 2006] describes these objectives as searching to learn. Learning searches involve multiple iterations and return sets of objects that require cognitive processing and interpretation. These objects may be instantiated in various media (graphs, or maps, texts, videos) and often require the information seeker to spend time scanning/viewing, comparing, and making qualitative judgments.

With these research-based guidelines in mind, we turn our attention to identifying the text mining and data visualization tools that best allow one to generate lists of features and customer perceptions by interacting with an archive of online reviews.

4. TEXT MINING FOR COMPETITIVE ANALYSIS

If online reviews are to serve as a source of competitive intelligence, then the reviews must provide data that discriminates amongst market entities and leads to actionable conclusions. Essentially, the value of the reviews depends upon how well one can predict a market entity from its reviews. In machine learning terms, we demand the reviews serve as inputs to a classification model with market entity as the target variable.

Classification models generate predictions by processing nominal and numeric inputs through algorithms such as the neural network or the decision tree. Our first task, then, is to convert the review text into vectors of suitable inputs. The most commonly used method of conversion is to parse the review collection into a term-document matrix A , where a_{ij} = the weight of term i in review j . Weighting schemes ranging from term frequency through log-entropy are available [Berry & Browne, 2005].

4.1 SUMMARIZING THE TERM-DOCUMENT MATRIX

Term-document matrices are always high-dimensional and sparse, making them difficult to use as input to a classification model. In practice, the term-document matrix is summarized before processing by the classifier. The summarization we use in this paper is Latent Dirichlet Allocation (LDA), one of the simpler algorithms for probabilistic topic modeling [Blei, Ng, & Jordan, 2003].

The following description of LDA from [Chaney & Blei, 2012] is suitable for our purposes.

LDA decomposes a collection of documents into *topics* -- probability distributions over terms --and represents each document with a (weighted) subset of topics. When fit to a set of documents, the topics are interpretable as themes in the collection, and the document representations indicate which themes each

document is about. Thus, the learned topics summarize the collection, and the document representations organize the corpus into overlapping groups.

So, LDA transforms each review into a vector of weights showing the strength of each topic in the review, where a topic is a probability distribution over the set of terms used in all reviews in the archive. An LDA topic is usually represented by showing a handful of the highest probability terms in the distribution. For example, the terms *room, comfortable, beds, large, clean, king* might come together in an LDA topic, and the extent to which these terms are used in a given review will be reflected in the size of the weight corresponding to the topic in the vector representing the review.

Machine learning classification models are part of what [Breiman, 2001] calls the *algorithmic modeling culture*. The approach is to find an algorithm that operates on inputs to predict responses. The approach was developed to work on complex prediction problems, such as speech recognition and computer vision, where it was obvious that traditional data models such as linear regression were not applicable.

Like least-squares linear regression, algorithmic classifiers are fit to a data set, called the training set, consisting of both inputs and responses. Rather than goodness-of-fit, the fit is guided by predictive accuracy, and tested on hold-out cases, called the test set, that were not considered in fitting the parameters of the algorithm. Dozens of algorithms have been developed over the past three decades, and model selection is still an active area of research [Shalizi, 2014].

For market segmentation, we seek an algorithm that provides both accuracy and interpretability, two qualities that often conflict. Without interpretability, we cannot identify the competitive factors that matter to consumers, and without accuracy we run the risk of choosing irrelevant factors upon which to compete or of overlooking important factors completely. One algorithm that provides an effective compromise between accuracy and interpretability is the random forest [Breiman, Friedman, Olsen, & Stone, 1984; Breiman, 2001].

A random forest is an ensemble of decision trees. Decision trees are fit by splitting the training set into subsets based on one of the variables of the input vector. The process is repeated on each derived subset in a recursive manner. The recursion is completed when the subset at a node has all the same value of the target variable, or when splitting no longer adds value to the predictions. Different decision tree algorithms use different metrics for deciding the splitting variable and splitting value at each step of the recursion [Hastie, Tibshirani, & Friedman, 2011].

Significant improvements in classification accuracy have resulted from growing an ensemble of trees and letting them vote for the most popular class. In order to grow these ensembles, often random vectors are generated that govern the growth of each tree in the ensemble. An early example is bagging, where to grow each tree a random selection (without replacement) is made from the examples in the training set. Another example is random split selection where at each node the split is selected at random from among the K best splits.

In random forests, the test set error is estimated internally, during the run, as follows [Breiman & Cutler, 2002]:

- Each tree is constructed using a different bootstrap sample from the original data. About one-third of the cases are left out of the bootstrap sample and not used in the construction of the k th tree. These cases are said to be *out-of-bag*.
- Put each case left out in the construction of the k th tree down the k th tree to get a classification.
- At the end of the run, take j to be the class that got most of the votes every time case n was out-of-bag. The proportion of times that j is not equal to the true class of n averaged over all cases is the out-of-bag error estimate.

The improved accuracy of the random forest over the single decision tree comes at the expense of interpretability. The following procedure to determine variable importance is usually included in random forest software [Breiman & Cutler, 2002].

- In every tree grown in the forest, put down the out-of-bag cases and count the number of votes cast for the correct class.
- Now randomly permute the values of variable m in the out-of-bag cases and put these cases down the tree.
- Subtract the number of votes for the correct class in the variable- m -permuted out-of-bag data from the number of votes for the correct class in the untouched out-of-bag data.
- The average of this number over all trees in the forest is the raw importance score for variable m .

4.2 ADDING FEATURES AND OPINIONS

In order for a manager to respond to the results of an automated classifier, detail about the review contents is required. Some authors propose linking LDA topics to the individual documents [Chaney & Blei, 2012]. We propose also to include an additional level of information between the LDA topics and the reviews that relies upon concept-level sentiment analysis [Cambria, 2014].

Unless complaining about a specific incident, reviewers offer multiple opinions about multiple features of a product or service. These feature/opinion pairs are essentially the review contents of interest for market segmentation, hence we propose to link an LDA topic to the feature/opinion pairs contained in the high-scoring reviews for the topic. For context, we provide links to the sentences that contain the feature/opinion along with the full review text.

In [Garcia-Moya, Anaya-Sanchez, & Berlanga-Llavori, 2013], the authors present a novel methodology for retrieving product features from a collection of free-text reviews. The method relies upon a language modeling framework that combines a probabilistic model of opinion words and a stochastic mapping model between words to approximate a language model of features. We use the model to generate feature/opinion pairs and measure the strength of the pair

in the review using our own scoring function based upon the product of the feature word's probability times the sum of the probabilities of the opinion words matching the feature.

5. VISUALIZATION TECHNOLOGIES

A market segmentation based upon the text mining tools described above must process voluminous data from multiple sources. Such analyses are often done through visual analytics, a collection of tools and techniques that combines machine analysis with the human ability to perceive patterns and draw conclusions [Fan & Gordon, 2014]. The combination of human and machine strengths supports synthesis, exploration, discovery, and confirmation of insight from data.

A commonly used interface design for visual analytics is the dashboard where multiple displays are used interactively to interrogate the underlying data. The ReviewMap design must integrate our network of LDA topics, feature/opinion pairs, relevant sentences and full review text. In [Schneiderman, 1996], the author presents a visual information seeking mantra: *overview first, zoom and filter, then details on demand*. For overview of the multi-dimensional LDA topics, the parallel coordinates plot is described as a *clever innovation that makes some tasks easier, but takes practice for users to comprehend*. We propose to supplement our parallel coordinates plot in our dashboard with a plot of a two-dimensional projection of the full-dimension LDA topic data set. The GGobi software package [Cook & Swayne, 2007] performs an interactive grand tour [Cook, Buja, Lee & Wickham, 2008] of a high-dimensional space from which a user can choose a projection with good separation of points.

Our dashboard is presented using Tableau (www.tableausoftware.com), an interactive graphics platform suitable for Schneiderman's *zoom/filter and details on demand* functions. To the parallel coordinates plot and two-dimensional projection plot of the LDA topics, we add a list of feature/opinion pairs with scores, and bar charts showing numbers of reviews and feature/opinion pairs under consideration. Zoom/filter specifications are done on-screen, as is drill-down to relevant sentences and full review text. A screen shot of the dashboard appears in Figure 1. The underlying data set consists of 1,040 TripAdvisor reviews of three New York City hotels. The number of LDA topics is 30.

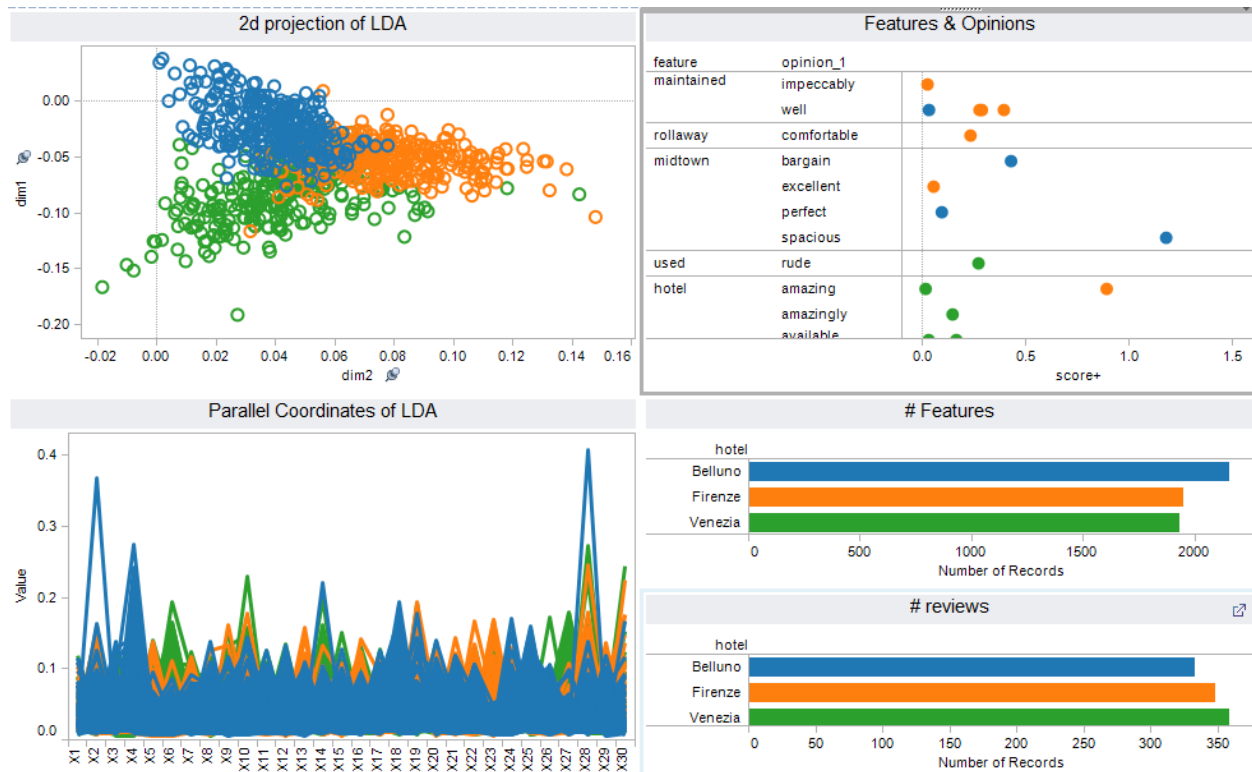


Figure 1. The ReviewMap dashboard. Representations of LDA analysis appear on the left. Sentiment analysis results are top right, with bar charts showing numbers of features and reviews in the current display. Selections made in one panel propagate to the others.

6. ReviewMap RESULTS

Our sample data set contains free-form text and numeric ratings for 1,040 reviews for hotels Belluno, Firenze and Venezia, all located in midtown Manhattan. There are 333 reviews for Belluno, 348 for Firenze, and 359 for Venezia. Our pre-processing was done in R (cran.r-project.org) using the text mining packages *tm*, *slam*, *RWeka*, *NLP* and *openNLP*. LDA analysis was done using the *MALLET* machine learning for language toolkit [McCallum, 2002]. Random forest classifiers were built using the R package *randomForest*, and feature/opinion pairs were generated by our own R-implementation of the [Garcia-Moya, Anaya-Sanchez, & Berlanga-Llavori, 2013] model.

Pre-processing consisted of removal of common words such as *the*, *at*, *also*, ... and hotel-specific words such as Belluno, Firenze, Venezia. All letters were made lowercase, and trailing spaces were added after punctuation marks that did not have them.

In the following sections, we consider ReviewMap's responses to the following customer segmentation/competitive questions.

- How well can one predict a hotel from its reviews?
- What is a given hotel's greatest perceived strength? And how important is that feature to competitors' customers?

- What features are "must-haves" to achieve a given level of ranking, e.g., top 10%?
- Which hotel is a given hotel's most significant competitor? Which hotel's customers are most like those of a given hotel?
- Can one identify effective competitive actions by comparing one's own reviews with those of a significant competitor?

6.1 CLASSIFIER RESULTS

Our first test of the discriminating power of the review text is a comparison of classifier performance with various input data sets and the hotel as target. We consider naive guessing, i.e., always choose Venezia because it has the highest frequency, random forest applied to the 1-to-5 numeric ratings, random forest applied separately to an LDA analysis with 30 dimensions, the LDA and numeric rating variables combined, the feature/opinion pairs alone, and the LDA and feature/opinion pairs combined. The results are summarized in Table 1 below. We note that the reviews for these three hotels were overwhelmingly positive. Approximately 90% of the numeric Overall Ratings were 4s or 5s out of 5 for each hotel.

| Method | Accuracy | Error Rate |
|---|----------|------------|
| Naive guess | 34.5% | 65.5% |
| Random forest applied to numeric ratings | 42.4% | 57.6% |
| Random forest applied to 30-dimensional LDA | 78.4% | 21.6% |
| Random forest applied to LDA and numeric ratings combined | 79.3% | 20.7% |
| Random forest applied to features/opinion pairs | 48.8% | 51.2% |
| Random forest applied to LDA and features/opinions combined | 77.5% | 22.5% |

Table 1. Random forest results for various input data sets.

From these results, we conclude

- reviews carry information specific to each hotel
- free-form text carries the bulk of the information.
- LDA topics are our best path into the archive

We turn our attention now to the ReviewMap system's customer segmentation goals of

1. drawing up a list of the features offered by the different brands in the market and
2. gathering data on how customers perceive those features.

6.2 IDENTIFYING STRENGTHS AND WEAKNESSES

We consider first the features of interest to one hotel's customers, but not the others. This can be done by examining the high values of each LDA topic for homogeneous content. An inclusion filter is created in Tableau by dragging a selection box over the points of interest in one of the screens. The other screens respond by showing their respective outputs for the reviews that were covered by the selection box.

Figure 2 shows the highest scoring reviews on LDA topic 4: *breakfast, coffee, free, tea, fruit, eggs...* Clearly, Belluno dominates the topic, and a review of the corresponding feature/opinion pairs and matching sentences reveals further details. The customers appreciated the free availability of a sit-down breakfast, and an "On the run" breakfast bag. They also noted the variety of items available, along with 24-hour free coffee and tea in the lobby, free internet, business center and fitness center. Drilling down to the free-form text revealed a collection of items similar to this one.

This hotel boasts a free breakfast which runs from 6am-10am. There are two dining rooms full of tables and chairs and the decor (here and throughout the hotel) is a very nice contemporary; comfortable design. The hotel changed their hot breakfast selections daily (waffles/sausage; eggs/sausage; etc.). There was also a variety of bakery items such as biscuits; cinnamon biscuits; sweet bread; muffins; bagels and toast. Other items offered were: ready to make oatmeal; cereal; fresh fruit and fruit salad as well as a variety of juices; milk; coffee and hot chocolate. It would be difficult for someone to not find something they like!

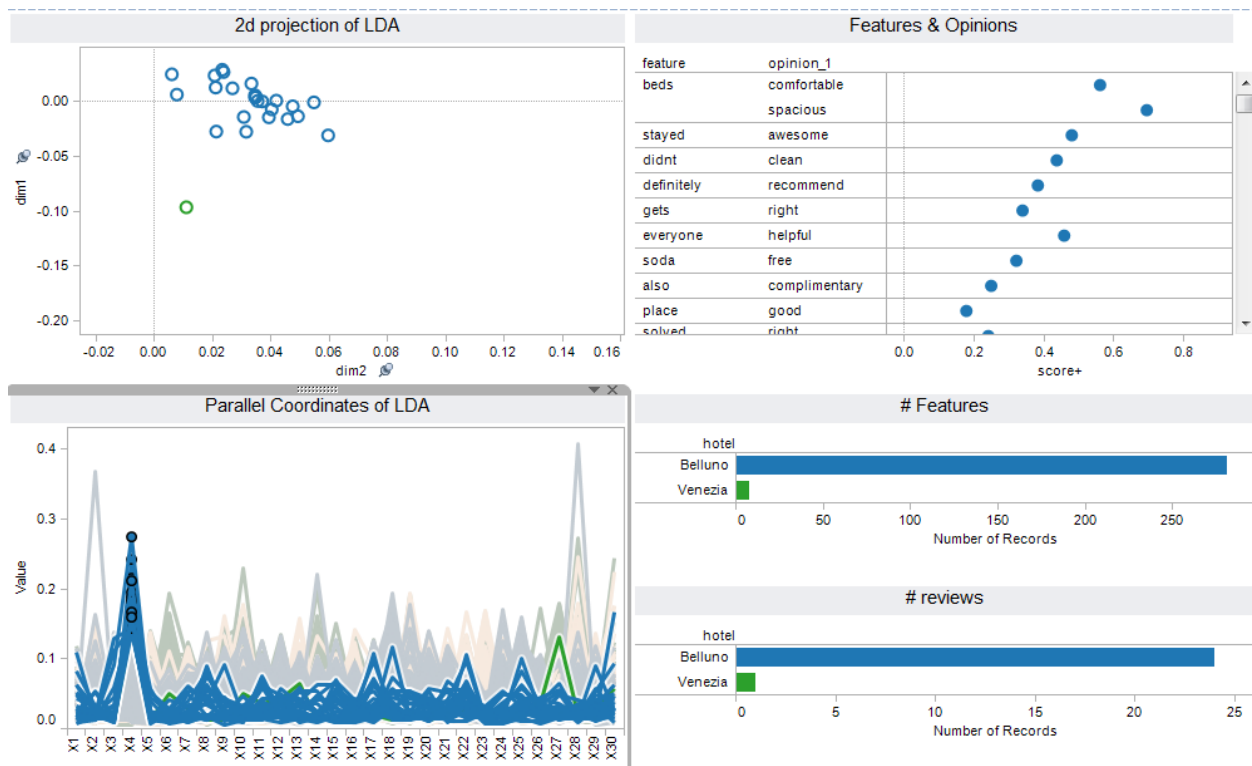


Figure 2. High scoring reviews on LDA topic 4: *breakfast, coffee, free, tea, fruit, eggs...*

This information can be used for competitive actions through advertising and staff development. The Belluno website displays information about free amenities on their website's opening page. Every piece of communication to customers should do the same, and the importance of these amenities should be included in all staff training programs. These results should also make their way to top management for firm-wide resource allocation decisions. A decision-maker

considering the elimination of some or all of these free amenities in an effort to reduce costs should be aware of just how important the amenities are to customers and how closely customers identify the amenities with the Belluno brand.

Apparently, some hotels are missing this relatively easy to find information. A leading LDA topic for Venezia customers is LDA topic 6: *view amazing fantastic* (specifics of view withheld). These high-scoring reviews refer to the view of a landmark NYC site from many of the rooms. Many reviewers post snapshots of this view on TripAdvisor, but there is no picture of the view on the Venezia website. The enthusiasm shown below is typical of the reviews scoring well on this topic, which the random forest algorithm identified as having the highest power of discrimination for Venezia.

The rooms are modern and comfortable; but the best feature of every room is the OUTSTANDING view. Even the gym faces the *landmark NYC site* I would definitely recommend this hotel to anyone. To see for yourself; I posted a video of my stay...

When we arrived at the hotel; we were awed by the beautiful lobby and restaurant spaces; especially the main entrance; which faces *NYC landmark*. The view of the *landmark* from the gilt lobby area is truly magical (made us feel as if we were in Europe). I had stayed in *competing hotel* the previous year; and although I found the common spaces there to be lovely; I'd have to say that the Venezia beats out the *competing hotel*; especially given the view of the *landmark*.

6.3 IN THE EYE OF THE BEHOLDER

LDA topics whose high value reviews have heterogeneous content represent items of interest to all reviewers. Figure 3 shows a filter on high scoring reviews for topic 26: *staff, helpful, friendly, stay, wonderful, extremely*.

One can see in the Features & Opinions panel that Belluno dominates the staff/friendly feature/opinion pair. Does this mean Firenze and Venezia staff are unfriendly? A review of the full list of feature/opinion pairs reveals that Firenze and Venezia reviewers tend to comment on individuals rather than the "staff." These reviews name check-in, housekeeping, concierge, bellman, etc. when describing friendly and helpful encounters, and we conclude that friendly staff are found at all three hotels. Whether the linguistic differences in the reviews are due to differences in the reviewers or staffs requires further investigation.

This scenario reveals an important issue regarding how one draws conclusions from natural language processing models. At least for the moment, proper use of these models requires a combination of machine and human intelligence. A visualization platform with flexible query and rich display capabilities is essential. For the analysis above, we used only a few mouse movements to isolate all feature/opinion pairs containing the opinion word *friendly* and to make

a visual and tabular assessment of the distribution of hotels amongst these items. We also determined that *unfriendly* and *unhelpful* opinion pairs occurred with very low frequency and equally across the three hotels as well.

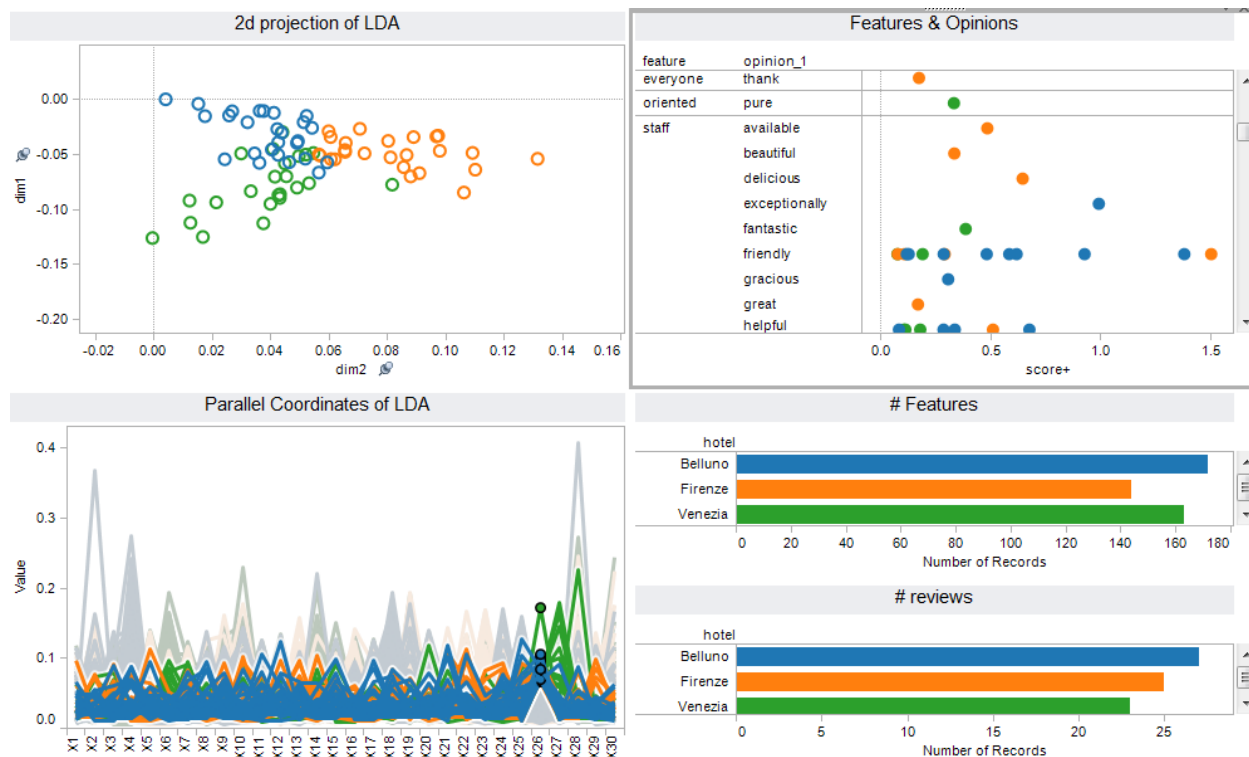


Figure 3. Topic 26: staff, helpful, friendly, stay, wonderful, a topic whose high scoring reviews are heterogeneous.

ReviewMap data clearly must be considered exploratory. As such, confirmatory analyses must follow relatively new procedures that attempt to adapt the concepts of test statistics, tests, null distributions, significance levels and p-values to visualization results [Buja et al, 2009; Hubbard, 2014]. These procedures are beyond the scope of this paper, and will be considered in future work.

6.4 WHO ARE OUR COMPETITORS?

The analyses presented so far follow a path from linguistics, i.e. the LDA components, to features/opinions to free-form text to draw conclusions about competitive relationships. In the following analyses, we begin with the apparent competitive relationships shown in the 2-dimensional projection of the LDA components and search the corresponding feature/opinion pairs for explanatory details.

Figure 4 shows a filter of the middle of the 2d projection cloud. We look to these reviews to find factors important to all reviewers regardless of hotel. Comparing the parallel coordinates plot in Figure 4 to that of Figure 1, one can see each hotel's "true believers" have been filtered out. We see a Firenze review showing at the top of component X4 (*breakfast, coffee, free, tea, fruit, eggs*) in Figure 4, where in Figure 1, that component is dominated by Belluno. Heterogeneity can now

also be seen in components X6 (*view, amazing, fantastic*), originally dominated by Venezia, and in component X23 (*beautiful, suite, upgraded, special*), originally dominated by Firenze.

An examination, therefore, of the feature/opinion pairs for these filtered reviews should reveal the components necessary to compete at the 20th percentile of New York City hotels. Value for the money, room cleanliness, bed, bath, service and location were cited by all in mostly positive comments. Negative comments were posted by those who found these features lacking.

In this center cloud of points, it was not possible to distinguish between higher-priced Firenze and Venezia reviewers. It was, however, still possible to identify many Belluno reviewers through their enthusiasm for the free amenities and for the hotel's location near the subway, (LDA component 18).

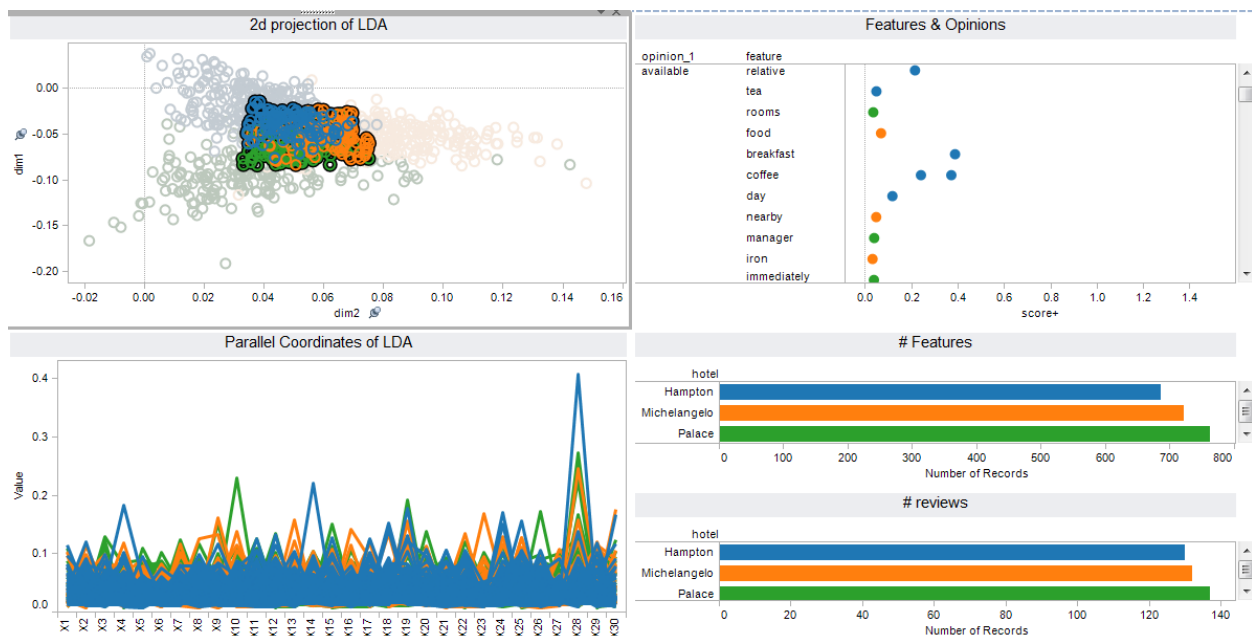


Figure 4. A subset of the most similar reviews that span all three hotels.

6.5 GOING HEAD-TO-HEAD

In our next analysis, we focus on the Firenze-Venezia competition by selecting a subset of reviews from the heart of each hotel's cloud of points in the *2D projection of LDA* panel of the Main Dashboard. See Figure 5. A drill-down to the features extracted from the 145 highlighted reviews revealed 10 features mentioned 10 times or more. To assess how reviewers perceive these features, we drill down further to the sentences containing these features. This was accomplished in Tableau by including the sentences in the *level of detail* list and mousing over a feature/opinion pair's mark.

For the feature *breakfast*, reviewers were equally negative complaining about cold food, crowded conditions, high cost of optional items such as orange juice, and slow service. For many, the

breakfast was the only negative feature in the review. Clearly, the Firenze and Venezia reviewers either have different standards or different experiences than the Belluno reviewers who thought the free breakfast was one of that hotel's highlights.

For the feature *room*, reviews of standard rooms were fair. Additional services such as turn-down, morning newspaper and flowers or chocolate upon arrival improved the tone of the review, and any kind of upgrade generated genuine enthusiasm. It was not possible to determine whether these upgrades occurred according to a hotel policy or at the discretion of the staff person, but based upon this feedback, an upgrade has significant impact on both Firenze and Venezia customers. Further investigation in how best to exploit this feature is indicated.

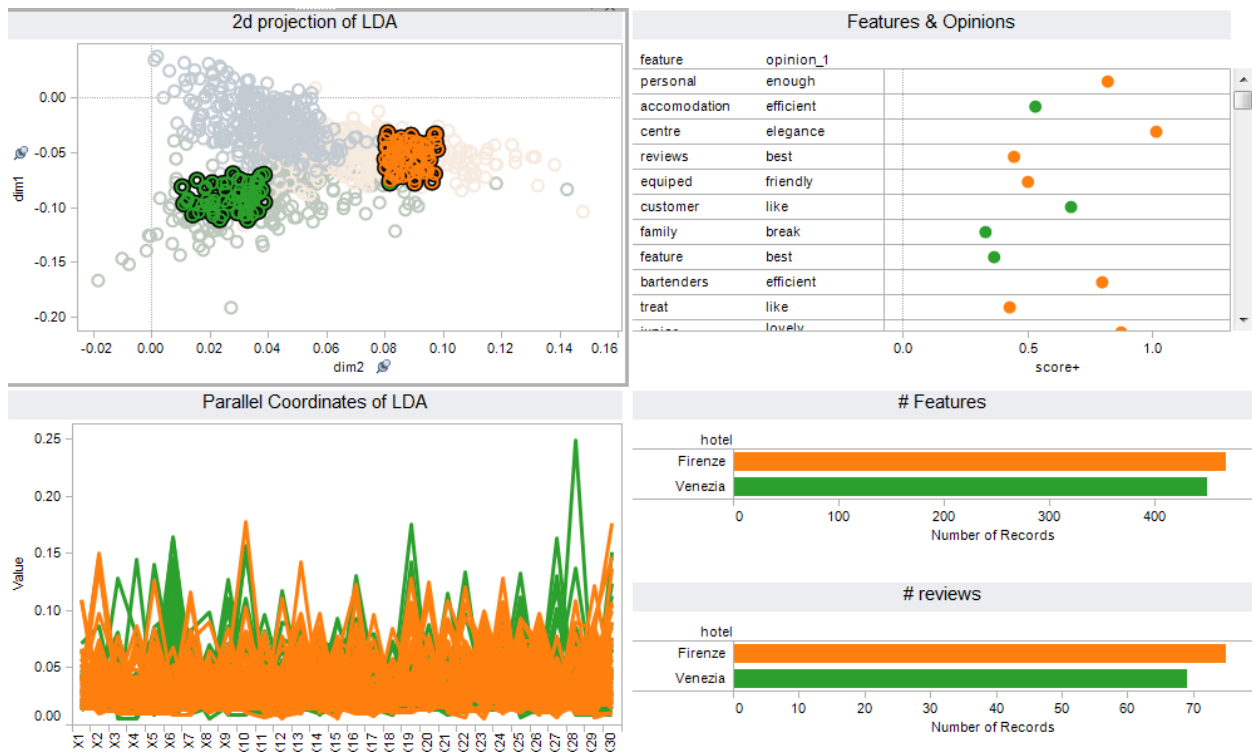


Figure 5. A query of mainstream Venezia and Firenze reviews.

Tableau allows one to change the definition of any display easily. For Firenze vs. Venezia reviews, we reversed the original feature-opinion sort order to opinion-feature. This allowed the examination of the distribution of hotel within feature/opinion pairs that contained superlatives such as *amazing*, *elegant* and *impeccable*. While the frequency of superlatives was similar for both hotels, we found a clear difference in the type of superlatives used. Firenze reviewers led in the use of *beautiful*, *elegant*, *gorgeous*, *luxurious*,..., while the Venezia reviewers led in the use of *amazing*, *fabulous*, *fantastic*... An examination of the features paired with these superlative opinion words showed that Firenze reviewers used superlatives to talk about hotel features such as the *room*, *bed* and *bathroom*, while the Venezia reviewers used superlatives for less intimate aspects of the hotel such as the *view*, *shopping* and *location*. A drill-down on the *room*, *bed* and

bathroom features for Venezia reviewers showed mostly satisfactory reports, some complaints, and almost none of the superlatives used by the Firenze group.

Firenze and Venezia management may have actionable intelligence in this observation. If the true reason for the observation is more luxurious interiors at the Firenze, then this plus their lower price and equivalent location could provide the basis for differentiating the Firenze from the Venezia. Other explanations of the observation are certainly possible, but Venezia management may want to investigate whether this difference corresponds to a genuine perception of fading interior quality amongst its customers.

7. DISCUSSION

Are online reviews worth reading? Does the feedback they provide tell managers anything they did not already know? Since online review archives are too large to process manually, the value online reviews deliver to managers is a function of the ability of text mining tools to support realistic analyses. In section 1 of this paper, we set two objectives for developing ReviewMap. 1) evaluate the capabilities of text mining tools to support realistic analyses and 2) evaluate the requirements these tools demand of the user. We addressed these objectives through customer segmentation/competitive analyses run on a sample of 1,040 TripAdvisor reviews for three hotels located in midtown Manhattan. A discussion of our progress toward these objectives follows in the next two sub-sections.

7.1 CAN TEXT MINING TOOLS SUPPORT REALISTIC ANALYSES?

ReviewMap processes an archive of online reviews spanning multiple suppliers into a hierarchy of data of increasing dimensionality. The levels of our hierarchy, in increasing order of dimensionality, are competitors, topics, features/opinions, feature-relevant sentences and full review text. Previous research, for example [Chaney & Blei, 2012], correctly recognized the need for such a hierarchy, and provided a platform that connected topics to full text. While this hierarchy provides valuable assistance to one browsing a collection, we found it too shallow to gather competitive intelligence within a reasonable time-frame.

The inclusion of the 2-dimensional projection of LDA components and the feature/opinion pairs and their corresponding sentences allows one to ask questions such as, "what is our greatest strength, and how important is that feature to our competitors' customers?" The search for an answer begins with an LDA component on which our customers score highly. The collection of all reviews that score highly on this component may be homogeneous or heterogeneous.

Heterogeneous is a simpler case because our customers and competitors' customers are talking about the same features, and we can identify the marks of each in the feature/opinion list by the color coding. If our high scoring components are homogeneous, then we need to check that competitors' customers are not using different language to address the features of the component before concluding the feature is of interest to our customers only.

ReviewMap results such as these show us the capabilities of text mining tools to support realistic analyses and the requirements these tools demand of the user. We were able to achieve classifier accuracy of almost 80% from the review text on a relatively small, overwhelmingly positive, data set. In addition, ReviewMap uncovered exploratory evidence of perceived strengths and weaknesses of each hotel, and provided intelligence for the consideration of competitive actions in advertising, customer service and brand quality.

7.2 DEMANDS ON THE USER

The most noticeable demand on the user is the amount of time required to understand the contents of the review collection. This is not surprising. The Searching to Learn tasks described in [Marchionini, 2006] clearly take time. The CRISP-DM data mining methodology includes Data Understanding as a major early step in any data mining project [Shearer, 2000], and [Breiman, 2001] advises us to "live with the data before plunging into modeling."

Organizations using ReviewMap and similar text mining/visualization systems, therefore, must manage their human resource commitment to the effort. Suggestions for this include direct, hands-on use of ReviewMap by domain experts rather than IT staff. The more people in the chain from pre-processed data to management action, the greater the chance of misinterpretation, omission and misplaced emphasis.

We found doing our analyses using pre-defined questions and search procedures to be more productive than bottom-up browsing, but that could be a result of our own cognitive styles, and may not apply to all users. Effective use of the tool, therefore, must include training and practice to develop each user's style of use. One size definitely will not fit all.

7.3 FURTHER WORK

Working with ReviewMap is clearly an exploratory activity. As such, we look to [Tukey, 1977] for a realistic assessment of what ReviewMap, in its current state, brings to management practice. ReviewMap utilizes modern computer technology to *look at data to see what it seems to say*. The system addresses an online review archive *to make it more easily and effectively handleable by minds*. The ReviewMap user should *regard whatever appearances he/she has recognized as partial descriptions, and try to look beneath them for new insights*.

The next step after a ReviewMap analysis could be a simple action such as the addition of a few images on a company's website or something more complex such as a pilot project to test new upgrade policies. If the user fears our multiple comparisons may be yielding spurious associations, confirmation studies can be carried out by monitoring future reviews for consistency with current observations or by using surveys and other data collection methods. Traditional statistical inference techniques, or emerging inference methods that rely upon visual data [Bua, 2009] are applicable depending upon the data collected.

Another option, available after confirmation studies, is to include ReviewMap observations in a Bayesian decision analysis to update models of uncertainty for decision-making metric values [Hubbard, 2014].

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CHASING SUCCESS IN NASCAR: A STATISTICAL LOOK INTO RACE FOR THE CHASE TOURNAMENT STRUCTURE TO ASSESS THE FOCUS ON WINNING RACES ACROSS THREE CHAMPIONSHIP FORMATS

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ABSTRACT

Since 2004, NASCAR has been modifying their format to increase the importance of wins in their Chase for the championship. This project takes a statistical look at their efforts, and compares the past 11 seasons to measure the effect. The model's development focuses on the drivers, and what factors represent them and their team's effort in the Chase. The analysis identifies significant factors that influence the championship standings and the strength and consistency of the key factor in predicting the accumulation of points towards the championship.

INTRODUCTION

Implementing the optimal championship structure within a sporting league is a prominent financial concern for the organizers and participants, and is of personal interest for fans. Tournament theory offers a rich basis to describe the design and governance of rank-order competitions, and gives insight into the strategies that individual participants employ to maximize their chances to win the tournament based on the tournament's structure and rewards [5] [6]. Individualistic sporting contests, such as NASCAR races, conform to the standard contest model, where probability of success depends on the efforts and abilities of the individual athlete [11]. Thus, the participants in NASCAR races can benefit from more in-depth quantitative analysis of the factors that influence individual driver championship standings. Previous research has identified variables that help to explain the outcomes of individual races and the number of top ten finishes for a season [1] [2] [8]. Among these factors identified, we want to determine if there is performance consistency among the variables. This research focuses on full seasons of NASCAR racing and tests the robustness of the model proposed by Pfitzner, Glazebrook and Rishel [7] that identifies the effect of several independent variables on NASCAR race results and the consistency of their bearing on Chase standings. To demonstrate the robustness of the model and the impact of explanatory variables on driver point accumulation, which result in the championship, we explore the model of variables in the season prior to the Chase and compare these outcomes to outcomes from the three versions of the Chase format as they evolved through the 2004-2013 seasons.

LITERATURE REVIEW

All organizations of professional sports place great importance on its determination of an overall champion for a specific season. Championship organizers have a significant impact on how much effort will be expended by the participants based on the structure of the tournament they choose to implement. Referring to tournament theory, participants are best motivated to perform when prizes are a function of relative performance (winners and losers) as opposed to absolute performance. The investments of participant's effort are only based on the differences between prize levels, and not the absolute size of the prize purse [5]. Expected total effort by each individual driver over all races increases with the spread of the prize among finisher places [10], although incentive effects diminish as the spread increases beyond a certain point for each individual driver [4]. Thus, choosing a championship structure that is sufficiently long to produce the superior team winning the series [12], yet intense enough to retain fan (consumer) interest is of paramount importance.

From the inception of the NASCAR circuit series as a professional sport through 2003, champions were determined based on a formula that took into account number of wins, number of Top 5 finishes, and number of Top 10 finishes, among other variables. The issue with this NASCAR Cup championship structure was that the winner was often determined mathematically long before the end of the season, decreasing fan interest and participant effort. The 2003 season exacerbated the situation where the 2003 champion, Matt Kenseth, only won one race with 25 Top 10 finishes, while another NASCAR driver, Ryan Newman, winning 22% of races that season did not win the championship because of DNFs due to crashes. Consistency in racing was clearly valued in a champion more than winning, which detracted from the excitement and urgency for drivers to win.

The Chase for the Cup championship structure was introduced in 2004 as a radical new system for crowning the NASCAR champion. Originally 10 drivers competed over the final 10 races of the season. By resetting and compressing the scoring of the top 10 drivers, the chances of each of those final drivers winning was increased, without precluding anyone with a legitimate chance of winning. The primary impetus behind instituting the Chase was to place the emphasis on winning races to have as much impact as performance consistency. For this research, the championship periods of analysis are divided into the pre-Chase period (2003 season and prior), the Chase I period (2004-2006 seasons), the Chase II period (2007-2010 seasons), and the Chase III period (2011-2013 seasons).

The Chase I race for the championship encompassed the last 10 races of the season and included the top 10 drivers in points in addition to any driver within 400 points of the leader. The leader began the Chase with 5,050 points, the second-place driver started with 5,045 points and the points decreased by five points through the list of contenders.

In 2007, the Chase format went through its first revision. According to Brian France, "The adjustments taken [Monday] put a greater emphasis on winning races. Winning is what this sport is all about. Nobody likes to see drivers content to finish in the top 10. We want our sport – especially during the Chase – to be more about winning [3]." To accommodate this, the top 12 drivers were now included in the Chase that continued to take place throughout the last 10 races

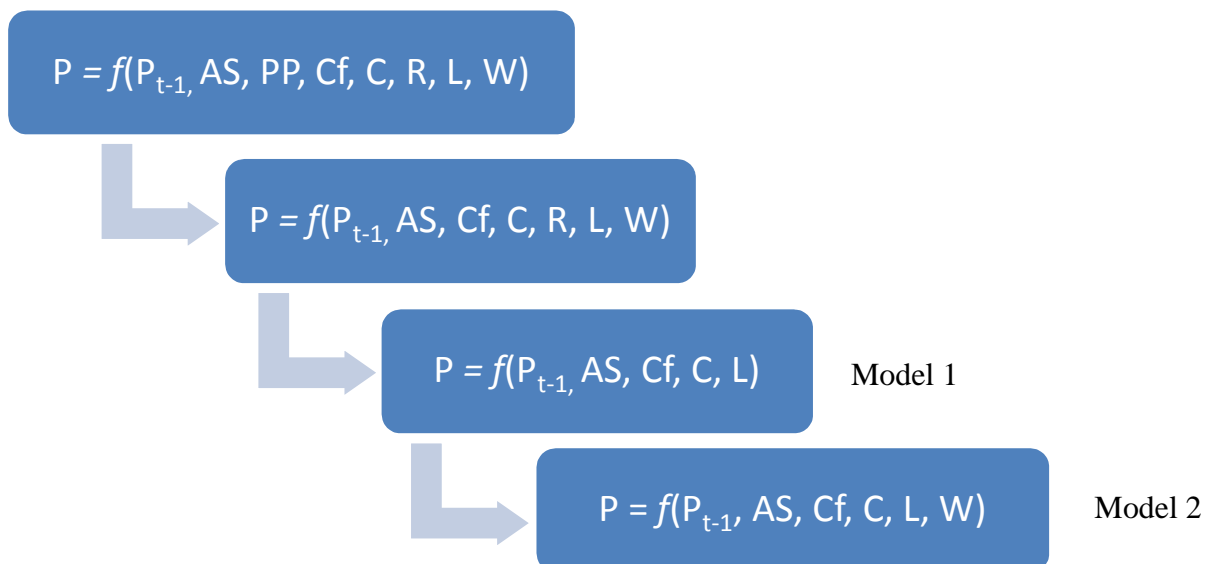
of the season. However in the Chase II format, the contenders' points were reset to 5000 points with a ten point bonus for each race won.

The Chase III format was created in 2011. In this revision, the top 10 drivers in points comprised the automatic contenders for the championship, again throughout the last 10 races of the season. Two wild card drivers were added to the Chase for the championship based on those with the most wins ranked in the 11th through the 20th positions in points. All 12 drivers had their points level reset to a base of 2,000 points per driver, with each of the 10 automatic contenders receiving a 3 point bonus for each win during the regular season. The two wild card contenders did not receive bonus points for wins when points were reset.

Prior research demonstrates the consistency of the model across different seasons of the Chase III era [9]. The goal of this work is to compare the pre-Chase and Chase III period models with the Chase I period model and the Chase II period results to determine if the changes to the NASCAR championship structure, through instituting the revisions to the Chase format, were successful in increasing the focus on winning races to make it an equal consideration to racing performance consistency. This research will serve as a basis for future research as NASCAR institutes a major revamp to its Chase for the championship by incorporating an eliminations structure in the 2014 season.

DESIGN OF THE MODEL

In creating a model to predict a champion in the NASCAR Cup Series, we developed a regression model to encompass the effort put in from teams and drivers to explain the points gained each season. The original concept model used the following variables to explain the points accumulated (P) in the Chase for the championship: the previous year's points earned (P_{t-1}), average starting position (AS), pole positions earned (PP), number of cars fielded (Cf), an intercept dummy variable for the Chase (C), rookie status (R), laps completed (L), and wins (W), so that $P = f(P_{t-1}, AS, PP, Cf, C, R, L, W)$. The model was tested and explanatory variables were updated accordingly to come up with the two final models used for comparison.



The pole position was removed since the information was already contained within the average starting position. The rookie status was not important by the time a driver reached the Cup series since they would have experience, whether it be in a competing series or a NASCAR sanctioned feeder series. The resulting regression models included some combination of the following explanatory variables, with individual's point accumulation serving as the dependent variable of interest. The final two models were left with the following data:

points_{t-1} = points earned for the prior year, represents consistency from year-to year.

average start = the average starting position for a given car/driver during the season of interest, a proxy for speed.

cars fielded = the number of cars/drivers an owner fields at the NASCAR Cup level, represents the team effect and perhaps economies of scale.

Chase dummy variable = a dummy variable equal to 1 if the driver qualified for the chase in the season of interest, and equal to zero otherwise.

laps = number of laps completed for all NASCAR Cup races for the season of interest, represents consistency in starting and completing races (obviously this variable depends on crew and other team characteristics as well).

wins = the number of wins for the season of interest.

The data for this project were collected from publically available NASCAR data, including the following websites:

http://www.nascar.com/en_us/sprint-cup-series/stats.html;

https://en.wikipedia.org/wiki/NASCAR_Rookie_of_the_Year;

https://en.wikipedia.org/wiki/2011_NASCAR_Sprint_Cup_Series; and

<http://www.racescorestats.com/Standings.aspx>.

The working model took two main forms looking at the impact of number of laps completed on the point accumulation towards the championship versus the number of laps and wins. The model was in the form of:

$$P_i = S_0 + S_1x_{1i} + S_2x_{2i} + \dots S_kx_{ki} + V_i$$

P_i = points earned

o = intercept

k = variable slopes

k = explanatory variables

i = error term

RESULTS

The regression models were evaluated using the adjusted R², standard error of the estimate (SEE), and the significance of the individual explanatory variables. Tests were also conducted for multicollinearity. The model showed constancy over the years (2003 – 2013), and supported the importance of laps completed in determining the NASCAR Cup Series Champion. The

regression models included previous year's points earned, average starting position, number of cars fielded, and an intercept dummy variable for the chase as explanatory variables. Average start position was consistently significant at the 0.01 level for all years, as was the chase dummy variable, which is as we would expect given the structure of the points accumulation for the Chase. The previous year's points and the number of cars fielded resulted in mixed significance. In seven out of eleven cases the previous year's points were significant at the 0.05 level or less, with four of the eleven years not being significant at all. In only three instances was the number of cars fielded significant at 0.10 or less.

Table 1 below contains adjusted R^2 , SEE, and the p-values for comparison of the two primary explanatory variables of interest, laps completed and wins. As illustrated in the table by the adjusted R^2 , laps completed clearly dominates the explanation of variance in points accumulated. This is true for both the year prior to the implementation of the Chase format (2003) as well as those years when the Chase for the championship was in effect. When laps completed was the only primary explanatory variable incorporated into the model (model 1), 92.3% of the variation in points was explained. This was the lowest adjusted R^2 and occurred in 2003, the last season before the Chase was put into effect. Once the Chase was implemented, between 97.3% and 99.5% of the variation in points was explained, with the three highest percentages occurring in 2011-2013, the most recent modification to the Chase format. With wins incorporated into the regression model as the second primary explanatory variable (model 2), it added very little to the explanatory power of the model, in some cases it decreased the SEE slightly, and it was significant at the 0.05 level only twice, in 2006 and 2010. In fact, Rishel et al. [9] showed that for the 2011 and 2012 seasons, a regression model with laps completed and the intercept dummy variable for the chase as the only explanatory variables represents an almost complete statistical explanation of driver points accumulated over a season. The 2011 adjusted R^2 value of 0.9837 and the 2012 adjusted R^2 value of .9822 mean that less than 2 percent of variation in driver points is left to be explained by factors other than laps completed.

Multicollinearity was evaluated in the regression models by first checking the signs and significance of the explanatory variables and also by using the variance inflation factor (VIF). In general there appears to be little issue. The 2008 season resulted in wins being insignificant and "wrong signed" in that as the number of wins increased the driver's points accumulation decreased. However the VIF was less than five, indicating an acceptable level of moderate correlation. Upon reviewing the data, the championship driver had 7 wins, while the 2nd and 10th place drivers had 9 and 8 wins respectively, thus possibly influencing the sign. In most cases wins was not significant, so this outcome is not surprising. In addition, the values of the regression coefficients in the 2008 models were minimally affected when wins was removed from the model, also negating problems associated with multicollinearity. In the 2010 models, previous year's points was "wrong signed" and not significant. But again, the VIF was less than five. In reality, the point accumulation from year-to-year may not always be positively correlated. In addition, there were several years when the previous year's points was not a significant explanatory variable in the model. Although there were indications of possible multicollinearity, the models appear to be reliable and robust.

Table 1: Regression outcomes for laps completed and laps completed plus wins

| Year | Adjusted R ² Laps | SEE Laps | Laps Completed p-value | Adjusted R ² Laps plus Wins | SEE Laps plus Wins | Wins p-value | Laps Completed p-value |
|-------|------------------------------|----------|------------------------|--|--------------------|--------------|------------------------|
| 2003* | 0.923 | 291.92 | 1.13E-11 | 0.924 | 289.43 | 0.206 | 9.47E-12 |
| 2004 | 0.973 | 286.46 | 7.35E-14 | 0.973 | 289.77 | 0.692 | 2.20E-13 |
| 2005 | 0.984 | 215.88 | 7.83E-22 | 0.985 | 207.75 | 0.054 | 6.08E-22 |
| 2006 | 0.969 | 284.73 | 9.33E-14 | 0.972 | 271.34 | 0.036 | 2.53E-14 |
| 2007 | 0.983 | 222.24 | 2.58E-16 | 0.983 | 220.95 | 0.239 | 3.40E-16 |
| 2008 | 0.983 | 226.35 | 1.42E-16 | 0.983 | 229.18 | 0.764 | 3.55E-16 |
| 2009 | 0.979 | 250.72 | 1.34E-14 | 0.979 | 248.74 | 0.215 | 1.40E-14 |
| 2010 | 0.982 | 245.69 | 1.26E-15 | 0.985 | 227.10 | 0.010 | 2.65E-16 |
| 2011 | 0.994 | 64.65 | 1.36E-16 | 0.994 | 63.47 | 0.132 | 1.10E-16 |
| 2012 | 0.994 | 64.10 | 8.07E-20 | 0.994 | 63.14 | 0.153 | 9.19E-20 |
| 2013 | 0.995 | 61.99 | 2.76E-19 | 0.995 | 62.70 | 0.682 | 8.10E-19 |

*Laps-squared was used for 2003 in both regression models since using this conversion outperformed the same regression models using laps.

CONCLUSIONS AND FUTURE RESEARCH

This research has a twofold purpose: 1) to determine if the model proposed by Pfitzner et al. (2014) is robust and identifies the same explanatory variables as being significant in predicting points accumulation for the NASCAR Chase for the championship over seasons 2004-2013; 2) to determine if the changes to the NASCAR championship structure, through instituting slight modifications to the Chase format, were successful in increasing the focus on winning races. The research was structured to compare the pre-Chase (2003 season and prior) with the Chase I (2004-2006 seasons), Chase II (2007-2010 seasons), and Chase III (2011-2013 seasons) period models in an effort to test the robustness and consistency of the models as well as whether NASCAR met their goal and did, in fact, increase the emphasis on winning.

As past research has shown, when drivers complete more laps they are more successful at making it into the Chase and perhaps winning the championship. In addition, there were consistent and significant effects for average starting position (representative of car speed), and previous year's points (representative of year-to-year driver consistency). However, the number of cars fielded and wins did not appear to be a factor in explaining the variation in point accumulation. These findings were based on comparing the 2003 pre-Chase season to the 2011 and 2012 Chase III seasons.

Evaluating all of the Chase seasons from 2004-2013, in addition to the pre-Chase season (2003), reinforced the previous findings and verifies the robustness of the regression model. The number of laps completed was consistently the strongest factor in predicting point accumulation throughout all of the revisions to the Chase format. Wins did contribute to the explanation of point accumulation, however this was true in only two years throughout the ten Chase seasons

and the pre-Chase season. In each of these two years, the overall power of the model (as measured by adjusted R^2) increased only slightly, by 0.2% and 0.3% respectively. Therefore, the Chase format continues to reward drivers for playing it safe and finishing a race as opposed to potentially taking unnecessary risks. That is not to say that drivers cannot complete many laps and win, but a “stay out of trouble” approach more often leads to success. Again, the results supported average starting position as an important factor as well as previous year’s points in seven of the eleven years evaluated. The number of cars fielded was not a strong or consistent factor in explaining the variation in point accumulation. This variable was significant in only three of the eleven seasons. Again, these outcomes were very consistent with previous research.

Given the fact that wins did not help explain the variation in point accumulation in nine out of eleven seasons, it does not appear that NASCAR achieved their goal of increasing the emphasis on wins throughout the evolution of the Chase format. The results of our study show that in the most recent version of the Chase format, seasons 2011-2013, where we would expect wins to be an even stronger factor, it turns out that wins is not a significant factor at all.

In the 2014 season NASCAR again modified the format for awarding points in the Chase for the championship to emphasize the importance of race wins and provide more “playoff-type” moments. Future research involves comparing the latest Chase point format to: 1) determine the robustness of the model across Chase I, II, III and Chase IV (2014) formats; 2) evaluate the significance and consistency of the variables, and 3) test if there has been any increase in the importance of wins in point accumulation.

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Do Clusters in Virginia Cluster According to Zipf?

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ABSTRACT

In this paper we test for congruence with Zipf's law among clusters in the Commonwealth of Virginia. We also update the tests of Zipf's law for cities (metropolitan areas) in the United States. We find that cities across the United States continue to conform to Zipf's law. However clusters in Virginia do not, while some samples of "cities" for Virginia do. We offer some general explanations for the differences in the Virginia results versus those obtained for United States.

INTRODUCTION

Dating to the year 1913, Felix Auerbach [1], a German geographer noted a very interesting empirical regularity regarding the distribution of the population of cities in a given geographic area. Let rank (R) represent the rank of the city population (that is, for the largest city, $R = 1$, and for the second largest city, $R = 2 \dots$). If S equals the size of the city population, and S is normalized to 1 for the largest city, then $R \cdot S = 1$, approximately. This means that the second largest city ($R = 2$, would have $\frac{1}{2}$ the population of the largest city; the third largest city ($R = 3$) would have $\frac{1}{3}$ the population of the largest city; and so forth. If Auerbach's observation is correct and S is not normalized, then $R \cdot S = A$, where A is a positive constant (and in theory equal to the population of the largest city). This empirical regularity has become best known as Zipf's law [14] for cities based on his 1949 work—though Zipf's original work was on the frequency with which individual words were used.

BRIEF LITERATURE REVIEW

The literature is replete with empirical tests of Zipf's law. Nitsch's [10] 2005 summary paper includes 29 previous studies in his meta-analysis. Nitsch claims that many studies do not confirm Zipf's law (though he finds the mean estimate to be approximately consistent with the law). Most scholars, however, generally agree that Zipf's law does hold, at least for the largest cities in a given geographical area.

Krugman's often cited 1996 paper [8] confirms that the largest 130 metropolitan areas as defined by the Census Bureau conform to Zipf's law. Krugman also raises another important point regarding economic theory and empirical results. Generally, economic

theory is most always simple and neat, whereas economic reality is often messy and complicated. With regard to Zipf's law, this relationship between theory and reality is reversed—in Krugman's words, "... we have complex, messy models, yet reality is startlingly neat and simple." Put plainly, there is no convincing economic explanation (even with messy theory) of city populations' adherence to Zipf's law.

Other research related to Zipf's law has proceeded in interesting directions. Research has suggested a connection to Benford's law, and, perhaps more productively, to Gilbrat's [6] rule. That rule states that the size of a firm and its growth rate are independent. The result of such a process gives rise to a log-normal distribution. The upper tail (here largest cities) of a log-normal distribution conforms to Zipf's law (see [4] for more detail).

As Krugman [8] noted and Rosen and Rennick [11] show, the more carefully cities are defined, the better the fit of Zipf's law to the data. Following this line of reasoning, Jiang and Jin [7], noting that cities are usually administratively defined, propose an alternative method. They employ a process to detect clustering based on street nodes (including intersections and ends) to define what they term *natural cities* for the entire United States. The method does not depend on Census definitions at all; rather it is a "bottom-up" approach. Utilizing different "resolutions" they define as many as 4 million natural cities for the US. They then find that the entirety of their defined cities (not just the upper tail) conforms to Zipf's law.

Still other research attempts to provide economic explanation for the frequently found regularity of Zipf's law applied to cities. Krugman [8] employs Simon's [13] urban growth model and is able to show that city populations could be consistent with a power law, but has difficulty in predicting with theory the coefficient of 1 that would represent a Zipf distribution. In short, the convergence process is infinitely long and requires unrealistic growth rates for some cities (see [4], pp. 754-55 for a summary). Axtell and Florida [2] apply a micro-foundations model *capable* of explaining a Zipf distribution of firm size and cities. The intuition of their model is that people co-operate to form firms and firms co-locate to form cities with the resulting population distribution conforming to Zipf's law. These authors admit that other models could be imagined that would give rise to similar results.

METHODOLOGY

Given the general proposition by Auerbach and Zipf, many empirical tests have been conducted seeking to verify (or contradict) Zipf's law. These tests take the following general form. Repeated from the introduction, let $R_i \cdot S_i = A$, where i references the individual city, then the following equation is estimated by ordinary least squares:

$$\ln R_i = \ln A - \alpha \ln S_i . \tag{1}$$

If Zipf's law holds approximately, the estimate of α is close to 1. A represents the population of the largest city in the data set.

The form in (1) can be re-formulated with S on the left-hand side, with the coefficient to be estimated attached to R . That coefficient would be expected also to be near 1 as well (it is the reciprocal of α) if Zipf's law were to hold. Nitsch [10] calls equation (1), the "Pareto" form and the other formulation, the "Lotka" form. The existing literature includes numerous estimates of each type.

RESULTS: LARGEST CITIES IN THE US

Krugman [8] estimates an equation equivalent to (1) above for 1991 data on the 130 largest metropolitan areas in the U.S. His estimate of α was 1.004, remarkably close to 1 and thus consistent with Zipf's law. Here we replicate Krugman's regression for the latest available data, population estimates from the year 2012.

The estimated equation is:

$$\ln R_i = 18.9094 - 1.08132 \ln S_i \quad (2)$$

(0.0148)

The standard error is in parentheses. The explanatory power of the estimation is impressive, $\bar{R}^2 = 0.98$.

The estimated coefficient is very close to 1, though it differs from 1 in the statistical sense. We conclude that US cities generally conform to Zipf's law for the most recent data.

The relationship is shown graphically in Figure 1.

APPLICATIONS TO VIRGINIA DATA

Census definitions

Purely out of curiosity, we wondered whether cities in Virginia (where we reside) followed Zipf's law. We collected two data sets in order to test the hypothesis. First we collected census data for urbanized areas and urban clusters, which are densely settled cores of contiguous census block groups and census blocks. An urbanized area has a total population of at least 50,000 people, while an urban cluster has a total population between 2,500 and 50,000 people. That data set identifies 73 such areas. We ran the general regression from (1) above with the following results:

$$\ln R_i = 8.9232 - 0.60184 \ln S_i \quad (2)$$

(0.0121)

$$\bar{R}^2 = 0.972$$

Figure 2 is the graphical representation of the regression.

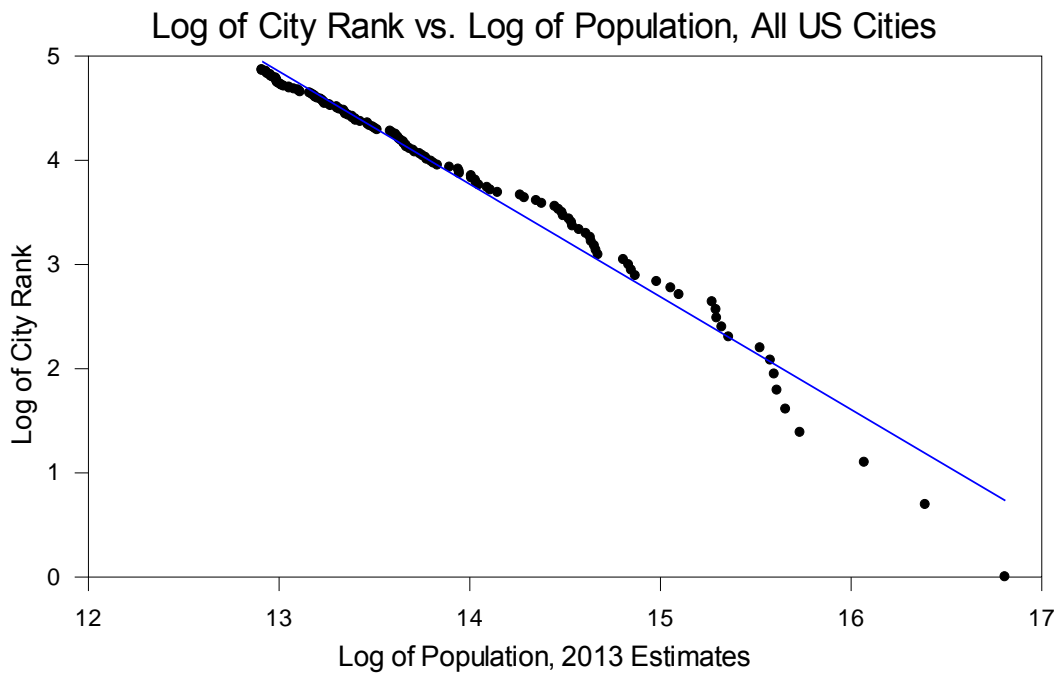


Figure 1: Regression of Log of City Rank on the Log of Population

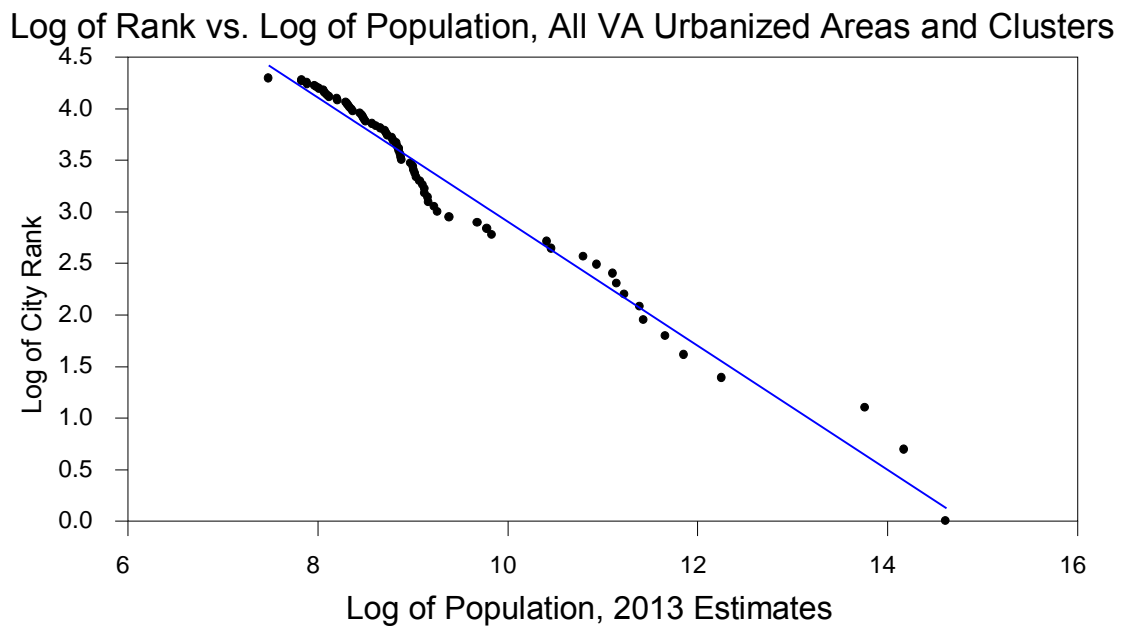


Figure 2: Zipf Regression, Virginia Urbanized Areas and Clusters

While the fit for the regression is very good, the coefficient estimate for α differs significantly from the $\alpha = 1$ result that would confirm Zipf's law for this data set. Recalling that Zipf's law is generally thought to hold for the largest cities in a given geographical area, we also experimented with the larger clusters and areas (e.g., populations exceeding 10,000) as a subset for the regression. In every case we were able to reject the hypothesis that $\alpha = 1$, even with some adjustments to the estimation procedures which we describe in the next set of regressions. We conclude that for these defined areas in Virginia, Zipf's law does not hold.

Political Definitions

Considering the Jiang and Jin [7] critique that cities are often administratively defined, we wondered if other definitions of Virginia cities might conform to Zipf's law. Cities and towns in Virginia are incorporated, and data on the populations are easily obtained. We next collected such a data set and performed the same set of tests. There are 110 cities and towns in that data set. A regression test for Zipf's law for the full sample of 110 yields the following results:

$$\ln R_i = 10.099 - 0.7095 \ln S_i \quad (3)$$

(0.0157)

$$\bar{R}^2 = 0.949$$

Again, the hypothesis that $\alpha = 1$ for this regression is rejected. The full data set does not conform to Zipf's law.

Once more, given the general conclusion that Zipf's law holds for large cities in a given geographical area, and that many of the cities and towns in Virginia are what most would consider small, we again chose a subset from Virginia cities and towns for yet another experiment. We chose cities whose populations exceeded an admittedly arbitrary cut-off of 20,000 in population. There are 27 such towns and cities in Virginia.

In their 2007 paper, Gabaix and Ibragimov [5] show that for (very) small samples, the estimates of α in regressions based on (1) are strongly biased, and the standard errors are underestimated. They further show that modifying rank by subtracting the constant $\frac{1}{2}$ from each rank is a remedy for the bias. They also show that the standard error of the α coefficient can be estimated as $S_e = \sqrt{\frac{2}{n}} * \hat{\alpha}_n$. The results of that regression are:

$$\ln R_i = 12.328 - 1.005 \ln S_i \quad (4)$$

(0.2722)

$$\bar{R}^2 = 0.907$$

Clearly here, Zipf's law is confirmed. The estimated coefficient is almost exactly 1, and of course does not differ from 1 in the statistical sense. (We should note that the "rank - 1/2" adjustment makes little difference in the estimation of α for the full sample of 110 in this section.) Figure 3 shows the results of the regression in (4).

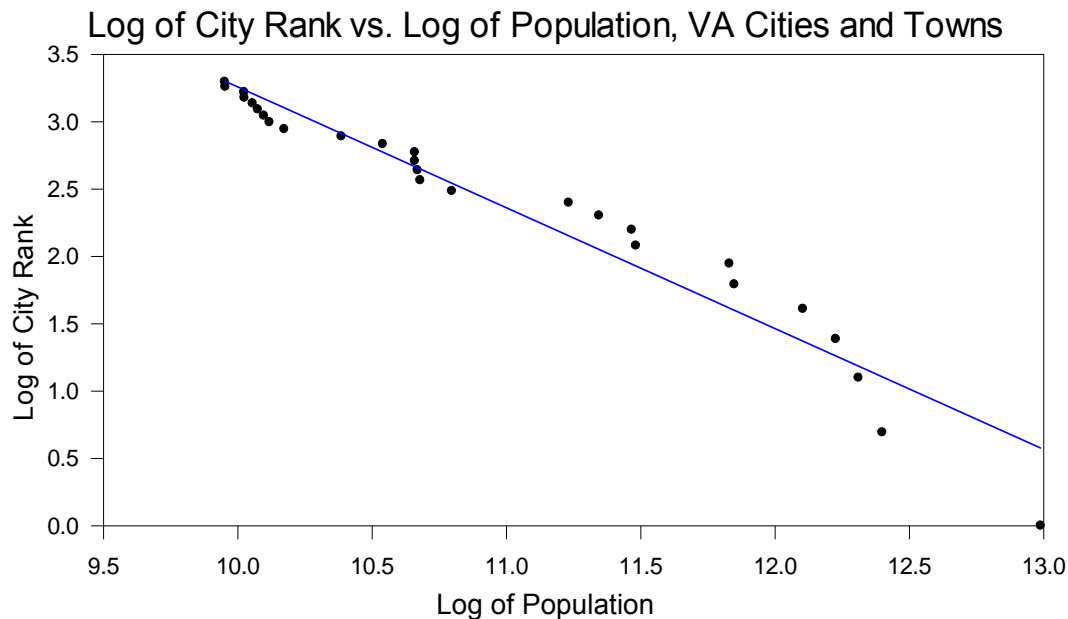


Figure 3: Zipf Regression, Large Virginia Cities and Towns

CONCLUSIONS

So where do these results leave us with the question originally posed? Do, in fact, clusters in Virginia cluster according to Zipf? Given the Census definitions, the answer appears to be a clear "NO." However, under the political definition of towns and cities, considering the largest cities and towns, the answer is clearly "YES." The statistical purist might argue the last result is the product of "data mining." We would not dispute such a claim, but would argue that choosing different definitions of cities and choosing the largest cities in a given geographical area is consistent with the spirit of the literature on Zipf's law.

Data derived from smaller geographical areas are likely to present, at the very least, some problems for tests of hypotheses such as Zipf's law. A state, or other such geographical subdivision, can be imagined to consist of few cities, one city, or even none at all. Jiang and Jin [7] (*natural cities*) find that Zipf's law holds for the US as a whole, but not for all individual states. They conclude that "Data and data size do indeed matter!" [7, p. 1278]. We concur.

We make no strong conclusions regarding whether clusters/cities in Virginia conform to Zipf's law. We have both contradictory and confirming evidence. The result depends on both how cities are defined and what constitutes large cities.

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An Empirical Study on Sell Side Stock Analysts' Recommendations around the Great Recession

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Abstract

We study whether there exist significant variations in sell side stock analysts' recommendations before, during, and after the Great Recession in the U.S. We choose six different industries, each of which includes six major stocks for this study. We show that even during the Great Recession, many stocks in our study did not receive any recommendations for strong sell from the analysts who followed these stocks. Furthermore, during the Great Recession, the dispersions measured by the standard deviations in each stock and each industry's recommendations did not significantly change comparing to those before and after the Great Recession. In addition, our findings support the stylized evidence reported in the literature that sell side stock analysts do not often issue sell and strong sell recommendations. This evidence is also present during the Great Recession in this study.

Keywords: Analyst recommendations; Great Recession

1. Introduction

The 2007-2009² Great Recession occurred in the U.S. has attracted significant research in many topics such as the reasons of occurring of the Great Recession and its impacts on the equity market; see Ball & Mazumder (2011), Fairlie (2013), Farmer (2012), Gomme, Ravikumar & Rupert (2011), Murphy (2008), and among others. During the Great Recession, the U.S. stock market experienced dramatic fluctuations in both stock prices and returns. The Dow Jones Industrial Average (DJIA) index dropped from 13,314.67 on December 03, 2007 to 8447.00 on June 30, 2009, losing 36.55% in the market value; the Standard & Poor 500 index plummeted

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² According to the National Bureau of Economic Research (NBER: <http://www.nber.org/cycles.html>), the Great Recession started in December of 2007, and ended in June of 2009.

from 1,472.42 to 919.32, losing 37.56% in the market value during the Great Recession; and the NASDAQ index dropped from 2,637.13 to 1,835.04, losing 30.42% in the market value during the same time period. Stock investors often use stock analysts' recommendations to gauge stock markets' overall movement, seek investment opportunities, and guide their investment decisions. It is interesting to study the mechanism of sell-side stock analysts' recommendations during this special period. Studying this topic may provide researchers and practitioners with insights into the behavior of the U.S. equity market. Specifically, we ask a question as to whether stock analysts' recommendations exhibit significant variations during the Great Recession. As such, the purpose of this empirical study is to compare the major statistical characteristics of the analysts' recommendations in the three consecutive business cycles prior to, during, and after the Great Recession³. Further, we test whether there exist significant variations in recommendations in these three periods. We choose in our study six different influential industries, namely Information Technology, Retailing, Pharmacy, Financial Services, Energy, and Real Estate. In each industry, the six largest stocks measured in market capitalization are included in this study. According to existing literature, popular or heavily traded stocks are often followed by stock analysts and the recommendations made on these stocks are influential in the stock market.

We show that even during the Great Recession, many stocks in our study did not receive any recommendations for strong sell from the analysts who followed these stocks. Furthermore, during the Great Recession, the dispersions measured by the standard deviations in each stock and each industry's recommendations did not significantly change comparing to those before and after the Great Recession. In addition, our findings support the stylized evidence reported in the

³ According to the National Bureau of Economic Research (NBER: <http://www.nber.org/cycles.html>), the business cycle right before the Great Recession was from 11/2001 to 11/2007; the Great Recession started in December of 2007, and ended in June of 2009; the business cycle right after the Great recession was from July of 2009 to present.

literature that sell side stock analysts do not often issue sell and strong sell recommendations. This evidence is also present during the Great Recession in this study.

The remainder of the paper is organized as follow. In Section 2, a brief literature review on related research is presented. In Section 3, we illustrate the research methodology. The data used in this research is described and the major statistics of the data are reported in Section 4. Section 5 presents the major empirical results and the analysis. Section 6 concludes.

2. Literature Review

Researchers have been studying the characteristics of stock analysts' recommendations with the consideration of macroeconomic characteristics and report that no significant difference is reflected in the EPS forecasting process during economic booms and busts. Dreman & Berry (1995) study the forecasts of EPS in different macroeconomic situations. Welch (2000) investigates the herding behaviors of financial analysts in economic expansions and contractions. Welch's study reveals that stock analysts' consensus in their recommendations tend to impose stronger influence when the market conditions are positively conceived. Jegadeesh et al. (2004) report that there exists bias in analysts' recommendations during different economic status such as expansions and recessions. More recently, Beber and Brandt (2010) study bonds' reactions to macroeconomic informational flow during different economic cycles and find that the impacts of macroeconomic information on bonds' returns differ in different economic cycles. And Hess et al. (2013) explore the information content and dissemination contained in buy side analysts' recommendations during economic expansions and contractions. They find that during economic recessions the bias in buy-side analysts' recommendations on "glamour" stocks turns out to be stronger. All these research provide insights into the relevance between analysts'

recommendations and macroeconomic status. In our study, we attempt to add insights into analysts' recommendations during the Great Recession, which is the second severe economic downturn in modern U.S. history.

3. Research Methodology

We focus on comparing the major statistical characteristics of the analysts' recommendations on the stocks in six different influential industries across the three consecutive business cycles around the Great Recession in the U.S. To answer the research question as to whether there are notable changes in the recommendations specific to a stock and an industry selected in this study, we compare the major statistics of sell side analysts' recommendations data for these stocks.

4. Data

We obtain the data from Institutional Broker's Estimate System (I/B/E/S). We choose six different industries, namely Information Technology, Financial Services, Retailing, Pharmacy, Real Estate included in REIT (Real Estate Investment Trust), and Energy. In each industry, we choose the six biggest stocks measured by market capitalization as of the end of 2012. Table 1 lists these stocks. The data span from December of 2001 to December of 2012. The data from I/B/E/S contain the recommendations made by sell-side analysts to the stocks they follow, the announcement dates, the activation dates, and the dates received by I/B/E/S, the names of the brokerage firms follow these stocks, and the names of the analysts who made these recommendations. There are five scales for analysts' recommendations, namely buy, strong buy, hold, sell, and strong sell. The I/B/E/S converted these recommendations to the Likert scales, where 1 = strong buy, 2 = buy, 3 = hold, 4 = sell, and 5 = strong sell.

Table 1 The List of the Stocks in the Six Industries

| Information | | | | | |
|-----------------------|---------------------------|-------------------|------------------|-------------------------|----------------------|
| Pharmaceutical | Financial Services | Technology | Retailing | REIT Real Estate | Energy |
| Johnson & Johnson | AIG | Apple | Walmart | Simon | Exxon Mobile |
| Pfizer | JPMorgan Chase | HP | Kroger | Public Storage | Chevron |
| Merck | Bank of America | IBM | Target | HCP | Schlumberger |
| Abbott Laboratories | Wells Fargo | Microsoft | Costco | Ventas | ConocoPhillips |
| Bristol-Myers Squibb | Citigroup | Dell | The Home Depot | Equity Residential | Occidental Petroleum |
| Eli Lilly | Prudential Financial | Intel | Walgreens | Health Care REIT | Enterprise |

Table 2 is the summary information about the recommendations made to each stock included in this study. In the pharmacy industry, Merck received the largest number of recommendations prior to the Great Recession, while Pfizer received the largest number of recommendations during the Great Recession. In the financial services industry, Bank of America gained the largest number of recommendations prior to and during the Great Recession, and continues to be recommended intensively after the Great Recession. In the information technology industry, Intel obtained the biggest number of the recommendations prior to and after the Great Recession, while Apple was most recommended during the Great Recession. In the retailing industry, Walmart and Target gained almost the same and the largest number of the recommendations by analysts, but Home Depot turned out to attract the biggest number of recommendations during the Great Recession. In the real estate sector, Equity Residential received the largest number of recommendations before the Great Recession, which happened to be the booming time for the residential housing market in the U.S. And this stock still obtains the largest number of recommendations by analysts after the Great Recession. In the energy industry, Schlumberger

turns out to be the most recommended stock in all the three business cycle around the Great Recession.

Table 2 Recommendations for Each Stock in the Three Time Periods

| Industry | Firms | 11/2001 - 11/2007 | 12/2007 - 6/2009 | 7/2009 - present |
|--------------------|------------------------|--------------------------|--------------------------|--------------------------|
| | | Total Recommendations | Total Recommendations | Total Recommendations |
| Pharmaceutical | Abbott Laboratories | 87 | 13 | 49 |
| | Bristol-Myers Squibb | 143 | 28 | 57 |
| | Johnson & Johnson | 131 | 21 | 53 |
| | Eli Lilly | 129 | 29 | 48 |
| | Merck | 155 | 22 | 42 |
| | Pfizer | 134 | 32 | 50 |
| | AIG | 94 | 30 | 50 |
| | Bank of America | 139 | 56 | 71 |
| Financial Services | Citigroup | 106 | 28 | 66 |
| | JPMorgan Chase | 103 | 38 | 73 |
| | Prudential Financial | 82 | 26 | 44 |
| | Wells Fargo | 122 | 51 | 71 |
| | Apple | 157 | 60 | 113 |
| | Information Technology | Dell | 199 | 48 |
| HP | | 47 | 41 | 86 |
| IBM | | 139 | 16 | 61 |

| | | | | |
|-------------------------|--------------------|-----|----|-----|
| | Intel | 255 | 58 | 137 |
| | Microsoft | 156 | 48 | 98 |
| Retailing | Costco | 128 | 29 | 58 |
| | The Home Depot | 127 | 38 | 58 |
| | Kroger | 72 | 24 | 44 |
| | Target | 145 | 29 | 67 |
| | Walgreens | 85 | 20 | 76 |
| | Walmart | 143 | 32 | 61 |
| REIT Real Estate | Equity Residential | 111 | 36 | 74 |
| | Health Care REIT | 46 | 8 | 31 |
| | HCP | 70 | 22 | 39 |
| | Public Storage | 71 | 23 | 60 |
| | Simon | 85 | 15 | 54 |
| | Ventas | 34 | 14 | 27 |
| Energy | ConocoPhillips | 135 | 27 | 68 |
| | Chevron | 147 | 19 | 49 |
| | Enterprise | 59 | 9 | 45 |
| | Occidental | | | |
| | Petroleum | 123 | 29 | 51 |
| | Schlumberger | 159 | 56 | 78 |
| | Exxon Mobile | 152 | 30 | 61 |

5. Empirical Results

To understand the evolution of the analysts' recommendations to each stock included in our study in the three business cycles around the Great Recession, we calculate the major statistics

based on the I/B/E/S recommendations. Tables 3, 4, and 5 present the details. For each stock, the tables list the mean, median, mode, and standard deviation of the observed recommendations during the three different business cycles. Furthermore, we report in the tables the percentages of the five scales of recommendations made for each stock in the three different time periods. It is

Table 3 Major Statistical Characteristics for Each Stock/Industry Prior to the Great

Recession: 11/2001 - 11/2007

| Industry | Firms | Mean | Median | Mode | Standard Deviation | Strong Buy | Buy | Hold | Sell | Strong Sell | |
|----------------|----------------------|-----------------|--------|------|--------------------|------------|--------|--------|--------|-------------|-------|
| Pharmaceutical | Abbott Laboratories | 2.310 | 2 | 3 | 0.968 | 22.99% | 33.33% | 35.63% | 5.75% | 2.30% | |
| | Bristol-Myers Squibb | 2.923 | 3 | 3 | 1.055 | 13.99% | 11.19% | 49.65% | 18.88% | 6.29% | |
| | Johnson & Johnson | 2.458 | 3 | 3 | 0.862 | 14.50% | 33.59% | 45.04% | 5.34% | 1.53% | |
| | Eli Lilly | 2.574 | 3 | 3 | 0.982 | 18.60% | 19.38% | 51.16% | 7.75% | 3.10% | |
| | Merck | 2.787 | 3 | 3 | 1.013 | 12.90% | 19.35% | 49.68% | 12.26% | 5.81% | |
| | Pfizer | 2.224 | 2 | 3 | 0.881 | 23.88% | 34.33% | 38.81% | 1.49% | 1.49% | |
| | Industry | 2.571 | 3 | 3 | 0.994 | 17.33% | 24.39% | 45.70% | 8.99% | 3.59% | |
| | Financial Services | AIG | 2.021 | 2 | 2 | 0.916 | 32.98% | 38.30% | 23.40% | 4.26% | 1.06% |
| | | Bank of America | 2.187 | 2 | 2 | 0.813 | 22.30% | 38.85% | 37.41% | 0.72% | 0.72% |
| Citigroup | | 2.302 | 2 | 2 | 0.948 | 21.70% | 37.74% | 30.19% | 9.43% | 0.94% | |
| JPMorgan Chase | | 2.515 | 3 | 3 | 0.839 | 11.65% | 34.95% | 44.66% | 7.77% | 0.97% | |
| Prudential | | 2.207 | 2 | 2 | 0.698 | 15.85% | 47.56% | 36.59% | 0.00% | 0.00% | |

| | | | | | | | | | | |
|-------------------------------|-----------------|-------|-----|-------|--------|--------|--------|--------|--------|-------|
| | Financial | | | | | | | | | |
| | Wells Fargo | 2.098 | 2 | 2 | 0.817 | 26.23% | 40.16% | 31.15% | 2.46% | 0.00% |
| | Industry | 2.22 | 2 | 2 | 0.854 | 21.98% | 39.32% | 34.06% | 4.02% | 0.62% |
| Information Technology | Apple | 2.363 | 2 | 3 | 0.841 | 17.83% | 32.48% | 46.50% | 1.91% | 1.27% |
| | Dell | 2.397 | 2 | 3 | 0.968 | 18.09% | 36.68% | 36.68% | 4.52% | 4.02% |
| | HP | 2.277 | 2 | 3 | 1.036 | 29.79% | 23.40% | 38.30% | 6.38% | 2.13% |
| | IBM | 2.353 | 2 | 2 | 0.867 | 15.11% | 42.45% | 37.41% | 2.16% | 2.88% |
| | Intel | 2.365 | 2 | 3 | 0.933 | 21.18% | 29.80% | 42.35% | 4.71% | 1.96% |
| | Microsoft | 1.987 | 2 | 2 | 0.811 | 30.77% | 41.67% | 26.28% | 0.64% | 0.64% |
| | Industry | 2.303 | 2 | 3 | 0.912 | 21.09% | 35.15% | 38.30% | 3.25% | 2.20% |
| Retailing | Costco | 2.570 | 3 | 3 | 1.001 | 17.19% | 24.22% | 47.66% | 6.25% | 4.69% |
| | The Home Depot | 2.268 | 2 | 3 | 0.904 | 24.41% | 30.71% | 38.58% | 6.30% | 0.00% |
| | Kroger | 2.569 | 3 | 3 | 1.005 | 18.06% | 23.61% | 44.44% | 11.11% | 2.78% |
| | Target | 2.241 | 2 | 3 | 0.959 | 26.90% | 29.66% | 37.93% | 3.45% | 2.07% |
| | Walgreens | 2.424 | 3 | 3 | 0.836 | 14.12% | 35.29% | 47.06% | 1.18% | 2.35% |
| | Walmart | 2.196 | 2 | 2 | 0.850 | 23.78% | 37.06% | 34.97% | 4.20% | 0.00% |
| | Industry | 2.353 | 2 | 3 | 0.936 | 21.57% | 30.43% | 41.00% | 5.14% | 1.86% |
| REIT Real Estate | Equity | | | | | | | | | |
| | Residential | 3.036 | 3 | 3 | 0.953 | 9.91% | 8.11% | 55.86% | 20.72% | 5.41% |
| | Health Care | | | | | | | | | |
| | REIT | 2.478 | 2.5 | 3 | 0.863 | 10.87% | 39.13% | 45.65% | 0.00% | 4.35% |
| | HCP | 2.686 | 3 | 3 | 0.910 | 14.29% | 17.14% | 55.71% | 11.43% | 1.43% |
| | Public Storage | 2.915 | 3 | 3 | 0.937 | 8.45% | 16.90% | 54.93% | 14.08% | 5.63% |
| | Simon | 2.306 | 2 | 2 | 0.859 | 17.65% | 41.18% | 35.29% | 4.71% | 1.18% |
| | Ventas | 2.000 | 2 | 3 | 0.853 | 35.29% | 29.41% | 35.29% | 0.00% | 0.00% |
| Industry | 2.662 | 3 | 3 | 0.962 | 14.15% | 23.02% | 48.68% | 10.79% | 3.36% | |

| | | | | | | | | | | |
|--------|-----------------|-------|---|---|-------|--------|--------|--------|-------|-------|
| Energy | ConocoPhillips | 2.363 | 2 | 3 | 0.935 | 20.00% | 34.07% | 37.04% | 7.41% | 1.48% |
| | Chevron | 2.592 | 3 | 3 | 0.889 | 15.65% | 19.73% | 55.78% | 7.48% | 1.36% |
| | Enterprise | 2.254 | 2 | 2 | 0.863 | 18.64% | 44.07% | 32.20% | 3.39% | 1.69% |
| | Occidental | | | | | | | | | |
| | Petroleum | 2.374 | 2 | 3 | 0.953 | 21.95% | 29.27% | 39.02% | 8.94% | 0.81% |
| | Schlumberger | 2.296 | 2 | 3 | 0.925 | 25.16% | 25.79% | 44.65% | 3.14% | 1.26% |
| | Exxon Mobile | 2.493 | 3 | 3 | 0.853 | 14.47% | 28.95% | 51.32% | 3.29% | 1.97% |
| | Industry | 2.412 | 3 | 3 | 0.911 | 19.35% | 28.65% | 44.90% | 5.68% | 1.42% |

observed that all the stocks included in this study received low percentages of sell and strong sell recommendations across all the three business cycles. Even during the Great Recession, many stocks did not receive any recommendations for strong sell from the analysts who followed these stocks. However, in the financial services industry, three stocks, namely AIG, Citigroup, and Well Fargo, indeed received remarkably high percentage of strong sell recommendations during the Great Recession. This evidence is concurrent to the fact that in the Great Recession, the financial services industry exhibited the most turbulent performance in the equity market. For example, the closing stock price of Citigroup plummeted to \$1.05 on March 9, 2009, compared to \$20.91 one year ago. In such a big shock in the stock market, it could impose significant impact on analysts' recommendations. Two other stocks in the financial services industry experienced the similar path during the Great Recession. The average scales in the recommendations across all the stocks, all the industries, and across all the three business cycles take values between 2 and 3 with a few exceptions. This indicates that the majority of the stocks were recommended for either buy or hold during the three time periods, including the Great Recession period. In the pharmacy industry, the mode of the recommendations stays at 3 in all

the three business cycles, and this pattern is observed in the information technology, retailing, and real estate industries. However, for the financial services industry, the mode of the recommendations before and after the Great Recession were 2, and changed to 3 during the Great Recession. This is in line with the overall performance of financial services sector in the equity market: before the Great Recession, the financial services sector was intensively invested. As such, many analysts issued buy recommendations to the investors. After the Great Recession, financial service sector also attracted investors due to the low pricing of the stocks and recovering momentum in the prices, and buy recommendations again dominate among the analysts who follow these stocks. During the Great Recession, analysts issued hold recommendations to this sector given the fact that the major stocks in this sector experienced

Table 4 Major Statistical Characteristics for Each Stock/Industry during the Great Recession: 12/2007 - 6/2009

| Industry | Firms | Mean | Median | Mode | Standard Deviation | Strong Buy | Buy | Hold | Sell | Strong Sell |
|----------------|----------------------|-------|--------|------|--------------------|------------|--------|--------|--------|-------------|
| Pharmaceutical | Abbott Laboratories | 1.923 | 2 | 2 | 0.760 | 30.77% | 46.15% | 23.08% | 0.00% | 0.00% |
| | Bristol-Myers Squibb | 2.750 | 3 | 3 | 0.928 | 14.29% | 10.71% | 64.29% | 7.14% | 3.57% |
| | Johnson & Johnson | 2.476 | 2 | 3 | 0.873 | 9.52% | 42.86% | 42.86% | 0.00% | 4.76% |
| | Eli Lilly | 3.000 | 3 | 3 | 0.886 | 6.90% | 13.79% | 55.17% | 20.69% | 3.45% |
| | Merck | 2.545 | 3 | 3 | 0.800 | 13.64% | 22.73% | 59.09% | 4.55% | 0.00% |
| | Pfizer | 2.094 | 2 | 2 | 0.818 | 25.00% | 43.75% | 28.13% | 3.13% | 0.00% |
| | Industry | 2.510 | 3 | 3 | 0.914 | 15.86% | 28.28% | 46.90% | 6.90% | 2.07% |

| | | | | | | | | | | | |
|---------------------------|-------------------------------|--------------------|-------|---|-------|--------|--------|--------|--------|--------|--------|
| Financial Services | AIG | 2.933 | 3 | 3 | 0.944 | 6.67% | 16.67% | 63.33% | 3.33% | 10.00% | |
| | Bank of America | 2.571 | 3 | 3 | 1.042 | 17.86% | 26.79% | 39.29% | 12.50% | 3.57% | |
| | Citigroup | 3.250 | 3 | 3 | 1.143 | 7.14% | 14.29% | 42.86% | 17.86% | 17.86% | |
| | JPMorgan Chase | 2.421 | 2.5 | 3 | 0.722 | 10.53% | 39.47% | 47.37% | 2.63% | 0.00% | |
| | Prudential Financial | 2.538 | 3 | 3 | 0.859 | 11.54% | 34.62% | 42.31% | 11.54% | 0.00% | |
| | Wells Fargo | 2.863 | 3 | 3 | 1.167 | 13.73% | 21.57% | 41.18% | 11.76% | 11.76% | |
| | Industry | 2.738 | 3 | 3 | 1.031 | 12.23% | 25.76% | 44.98% | 10.04% | 6.99% | |
| | Information Technology | Apple | 2.250 | 2 | 3 | 0.985 | 26.67% | 31.67% | 33.33% | 6.67% | 1.67% |
| | | Dell | 3.104 | 3 | 3 | 1.036 | 8.33% | 12.50% | 50.00% | 18.75% | 10.42% |
| | | HP | 2.537 | 3 | 3 | 0.778 | 7.32% | 41.46% | 41.46% | 9.76% | 0.00% |
| IBM | | 2.313 | 2 | 3 | 0.873 | 18.75% | 37.50% | 37.50% | 6.25% | 0.00% | |
| Intel | | 2.586 | 3 | 3 | 0.992 | 13.79% | 31.03% | 43.10% | 6.90% | 5.17% | |
| Microsoft | | 2.063 | 2 | 3 | 0.861 | 33.33% | 27.08% | 39.58% | 0.00% | 0.00% | |
| Industry | | 2.487 | 3 | 3 | 0.992 | 18.45% | 29.15% | 40.96% | 8.12% | 3.32% | |
| Retailing | Costco | 2.690 | 3 | 3 | 0.930 | 13.79% | 17.24% | 58.62% | 6.90% | 3.45% | |
| | The Home Depot | 2.553 | 3 | 3 | 0.921 | 15.79% | 23.68% | 52.63% | 5.26% | 2.63% | |
| | Kroger | 2.125 | 2 | 3 | 0.947 | 29.17% | 37.50% | 25.00% | 8.33% | 0.00% | |
| | Target | 2.517 | 2 | 2 | 0.911 | 10.34% | 41.38% | 37.93% | 6.90% | 3.45% | |
| | Walgreens | 2.600 | 3 | 3 | 0.940 | 15.00% | 20.00% | 60.00% | 0.00% | 5.00% | |
| | Walmart | 2.156 | 2 | 2 | 0.920 | 28.13% | 34.38% | 31.25% | 6.25% | 0.00% | |
| | Industry | 2.442 | 3 | 3 | 0.938 | 18.60% | 29.07% | 44.19% | 5.81% | 2.33% | |
| | Real Estate | Equity Residential | 3.167 | 3 | 3 | 0.941 | 2.78% | 19.44% | 44.44% | 25.00% | 8.33% |

| | | | | | | | | | | |
|---------------|-----------------|--------------|----------|----------|--------------|---------------|---------------|---------------|---------------|--------------|
| | Health Care | | | | | | | | | |
| | REIT | 2.750 | 3 | 3 | 0.463 | 0.00% | 25.00% | 75.00% | 0.00% | 0.00% |
| | HCP | 2.318 | 3 | 3 | 0.839 | 22.73% | 22.73% | 54.55% | 0.00% | 0.00% |
| | Public Storage | 3.174 | 3 | 3 | 0.937 | 4.35% | 13.04% | 52.17% | 21.74% | 8.70% |
| | Simon | 2.267 | 2 | 2 | 0.799 | 13.33% | 53.33% | 26.67% | 6.67% | 0.00% |
| | Ventas | 2.643 | 3 | 3 | 0.842 | 14.29% | 14.29% | 64.29% | 7.14% | 0.00% |
| | Industry | 2.805 | 3 | 3 | 0.936 | 9.32% | 22.88% | 50.00% | 13.56% | 4.24% |
| Energy | ConocoPhillips | 2.481 | 3 | 3 | 0.802 | 14.81% | 25.93% | 55.56% | 3.70% | 0.00% |
| | Chevron | 2.263 | 2 | 2 | 0.733 | 15.79% | 42.11% | 42.11% | 0.00% | 0.00% |
| | Enterprise | 1.444 | 1 | 2 | 0.527 | 55.56% | 44.44% | 0.00% | 0.00% | 0.00% |
| | Occidental | | | | | | | | | |
| | Petroleum | 2.517 | 3 | 3 | 0.829 | 10.34% | 34.48% | 51.72% | 0.00% | 3.45% |
| | Schlumberger | 2.339 | 2 | 2 | 0.793 | 12.50% | 46.43% | 37.50% | 1.79% | 1.79% |
| | Exxon Mobile | 2.400 | 3 | 3 | 1.003 | 23.33% | 23.33% | 46.67% | 3.33% | 3.33% |
| | Industry | 2.347 | 2 | 3 | 0.844 | 17.06% | 36.47% | 42.94% | 1.76% | 1.76% |

great drop in the prices. The energy industry, on the other hand, witnessed a change in the mode of the recommendations from 3 (hold) before and during the Great Recession to 2 (buy) after the Great Recession. This again reflects the recent focus on the new energy development in the U.S. economy. At the individual stock level, the majority of the stocks in the financial services industry experienced the same path as that taken by the industry. Notably, the investors of these stocks are recommended by analysts to buy before and after the Great Recession. In the information technology industry, only the Apple's stock gains a mode of 2 (buy) after the Great Recession, and all others in this industry continue to stay at 3 (hold) for their modes since the Great Recession. Regarding the dispersion of the recommendations for each stock and each

industry, it shows from Tables 3, 4, and 5 that the standard deviations of the recommendations are very stable with the majority of the values being below 1 across all the stocks, all the six industries, and across all the three business cycles. Even during the Great Recession, the dispersions in each stock and each industry's recommendations did not change much comparing to those before and after the Great Recession.

Table 5 Major Statistical Characteristics for Each Stock/Industry after the Great Recession: 9/2009 – present

| Industry | Firms | Mean | Median | Mode | Standard Deviation | Strong Buy | Buy | Hold | Sell | Strong Sell | |
|----------------|----------------------|-----------------|--------|------|--------------------|------------|--------|--------|--------|-------------|-------|
| Pharmaceutical | Abbott Laboratories | 2.490 | 3 | 3 | 0.960 | 14.29% | 34.69% | 44.90% | 0.00% | 6.12% | |
| | Bristol-Myers Squibb | 2.579 | 3 | 3 | 0.905 | 15.79% | 22.81% | 49.12% | 12.28% | 0.00% | |
| | Johnson & Johnson | 2.283 | 2 | 3 | 0.794 | 18.87% | 35.85% | 43.40% | 1.89% | 0.00% | |
| | Eli Lilly | 3.000 | 3 | 3 | 1.072 | 12.50% | 10.42% | 50.00% | 18.75% | 8.33% | |
| | Merck | 2.310 | 2 | 3 | 0.749 | 16.67% | 35.71% | 47.62% | 0.00% | 0.00% | |
| | Pfizer | 2.060 | 2 | 2 | 0.867 | 28.00% | 42.00% | 28.00% | 0.00% | 2.00% | |
| | Industry | 2.455 | 3 | 3 | 0.938 | 17.73% | 30.10% | 43.81% | 5.69% | 2.68% | |
| | Financial Services | AIG | 2.620 | 3 | 3 | 0.901 | 12.00% | 26.00% | 54.00% | 4.00% | 4.00% |
| | | Bank of America | 2.437 | 3 | 3 | 0.906 | 19.72% | 23.94% | 50.70% | 4.23% | 1.41% |
| Citigroup | | 2.333 | 2 | 2 | 0.865 | 15.15% | 45.45% | 31.82% | 6.06% | 1.52% | |
| JPMorgan Chase | | 1.945 | 2 | 2 | 0.762 | 28.77% | 50.68% | 17.81% | 2.74% | 0.00% | |

| | | | | | | | | | | |
|-------------------------------|-----------------|-------|---|-------|--------|--------|--------|--------|--------|-------|
| | Prudential | | | | | | | | | |
| | Financial | 2.250 | 2 | 2 | 0.719 | 13.64% | 50.00% | 34.09% | 2.27% | 0.00% |
| | Wells Fargo | 2.366 | 2 | 2 | 0.849 | 15.49% | 39.44% | 39.44% | 4.23% | 1.41% |
| | Industry | 2.312 | 2 | 2 | 0.860 | 18.13% | 39.20% | 37.33% | 4.00% | 1.33% |
| Information Technology | Apple | 1.982 | 2 | 2 | 0.954 | 35.40% | 39.82% | 17.70% | 5.31% | 1.77% |
| | Dell | 2.490 | 3 | 3 | 0.944 | 18.37% | 25.51% | 46.94% | 7.14% | 2.04% |
| | HP | 2.442 | 3 | 3 | 0.915 | 17.44% | 30.23% | 45.35% | 4.65% | 2.33% |
| | IBM | 2.574 | 3 | 3 | 0.884 | 16.39% | 19.67% | 54.10% | 9.84% | 0.00% |
| | Intel | 2.438 | 3 | 3 | 0.890 | 17.52% | 29.93% | 44.53% | 7.30% | 0.73% |
| | Microsoft | 2.245 | 2 | 3 | 1.036 | 28.57% | 29.59% | 34.69% | 3.06% | 4.08% |
| | Industry | 2.342 | 2 | 3 | 0.956 | 22.77% | 30.02% | 39.29% | 6.07% | 1.85% |
| Retailing | Costco | 2.655 | 3 | 3 | 0.890 | 10.34% | 29.31% | 46.55% | 12.07% | 1.72% |
| | The Home | | | | | | | | | |
| | Depot | 2.379 | 2 | 3 | 0.970 | 20.69% | 31.03% | 41.38% | 3.45% | 3.45% |
| | Kroger | 2.432 | 3 | 3 | 0.900 | 18.18% | 29.55% | 43.18% | 9.09% | 0.00% |
| | Target | 2.343 | 2 | 3 | 0.770 | 14.93% | 38.81% | 43.28% | 2.99% | 0.00% |
| | Walgreens | 2.618 | 3 | 3 | 0.816 | 9.21% | 30.26% | 51.32% | 7.89% | 1.32% |
| | Walmart | 2.557 | 3 | 3 | 0.922 | 16.39% | 22.95% | 50.82% | 8.20% | 1.64% |
| Industry | 2.503 | 3 | 3 | 0.877 | 14.56% | 30.49% | 46.43% | 7.14% | 1.37% | |
| REIT Real Estate | Equity | | | | | | | | | |
| | Residential | 2.865 | 3 | 3 | 0.881 | 5.41% | 24.32% | 54.05% | 10.81% | 5.41% |
| | Health Care | | | | | | | | | |
| | REIT | 2.516 | 3 | 3 | 1.029 | 19.35% | 25.81% | 41.94% | 9.68% | 3.23% |
| | HCP | 2.846 | 3 | 3 | 0.961 | 15.38% | 5.13% | 61.54% | 15.38% | 2.56% |
| | Public Storage | 2.717 | 3 | 3 | 0.904 | 11.67% | 21.67% | 51.67% | 13.33% | 1.67% |
| | Simon | 2.315 | 2 | 2 | 0.722 | 12.96% | 44.44% | 40.74% | 1.85% | 0.00% |
| Ventas | 2.630 | 3 | 3 | 1.006 | 18.52% | 14.81% | 55.56% | 7.41% | 3.70% | |

| | | | | | | | | | | |
|---------------|-----------------|-------|---|---|-------|--------|--------|--------|--------|-------|
| | Industry | 2.667 | 3 | 3 | 0.914 | 12.28% | 24.21% | 50.88% | 9.82% | 2.81% |
| Energy | ConocoPhillips | 2.691 | 3 | 3 | 0.996 | 14.71% | 23.53% | 41.18% | 19.12% | 1.47% |
| | Chevron | 2.163 | 2 | 2 | 0.874 | 20.41% | 51.02% | 22.45% | 4.08% | 2.04% |
| | Enterprise | 2.089 | 2 | 2 | 0.763 | 22.22% | 48.89% | 26.67% | 2.22% | 0.00% |
| | Occidental | | | | | | | | | |
| | Petroleum | 2.235 | 2 | 2 | 0.681 | 13.73% | 49.02% | 37.25% | 0.00% | 0.00% |
| | Schlumberger | 2.077 | 2 | 2 | 0.879 | 28.21% | 41.03% | 26.92% | 2.56% | 1.28% |
| | Exxon Mobile | 2.377 | 3 | 3 | 0.860 | 18.03% | 31.15% | 47.54% | 1.64% | 1.64% |
| | Industry | 2.284 | 2 | 2 | 0.883 | 19.89% | 39.49% | 34.09% | 5.40% | 1.14% |

Our findings support the stylized evidence reported in the literature that sell-side stock analysts do not often issue sell and strong sell recommendations. This evidence is also present during the Great Recession in this study. One of the explanations is that analysts tend to make optimistic forecasts on the earnings of the stocks they follow. See Francis and Philbrick (1993), Kang *et al.* (1994), Dugar and Nathan (1995), Lin and McNichols (1998), Michaely and Womack (1999), and Ramnath *et al.* (2008) for details.

6. Conclusion

The Great Recession occurred from late 2007 to mid 2009 in the United States caused remarkable impacts on stock market. How stock analysts' recommendations evolve during this economic recession is a very important question. In this study, we focus on investigating the variations of stock analysts' recommendations during the U.S. Great Recession. We show that even during the Great Recession, many stocks in our study did not receive any recommendations for strong sell from the analysts who followed these stocks. Furthermore, during the Great Recession, the dispersions measured by the standard deviations in each stock and each industry's

recommendations did not significantly change comparing to those before and after the Great Recession. In addition, our findings support the stylized evidence reported in the literature that sell side stock analysts do not often issue sell and strong sell recommendations. This evidence is also present during the Great Recession in this study.

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DEVELOPING A SURVEY FOR BIG DATA AND DATA SCIENCE SKILLS

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ABSTRACT

Many organizations are accumulating ever-increasing amounts of data with the intent of utilizing this resource to develop new products and services, extend existing ones, or create new efficiencies within the workplace. The realization that data can provide potentially significant strategic value has translated into a high demand for competent big data professionals; this demand shows no sign of abating anytime in the near future. In response, research has started looking into the knowledge, skills and abilities (KSAs) modern big data and data science professionals should ideally possess. Along these lines, this paper presents a brief review of the extant research on this issue and an outline for a survey instrument designed to gauge which skills are most important to industry and academics in the areas of big data and data science. Further, administration of this instrument is also discussed.

INTRODUCTION

The era of big data has arrived. The volume of stored data has increased tremendously over recent years and the trend shows no sign of slowing down. A recent report in ComputerWorld predicts that “by 2020, the quantity of electronically stored data will reach 35 trillion gigabytes” [13, p. 19]. Predictions of this nature abound in the popular press, with some estimating as much as a 300-fold increase in the total amount of stored data from 2005 to 2020 [41].

The projected growth in the big data market is on a similar trajectory. Wikibon projects that the big data market will reach \$28.5 billion in sales of related hardware, software and services in 2014 then increase by another 43% to \$50.1 billion in 2015 [24]. Wikibon further reports that 40% of big data market in 2013 was attributable to big data-related professional services [24]. This expected growth leaves little doubt that big data is here to stay and that the demand for big data professionals will continue to grow rapidly into the foreseeable future.

Big data has been described as that which has grown beyond the capability of traditional storage media and analytical techniques. Chen, Chiang and Storey [11, p. 1166] characterize big data as “... *the data sets and analytical techniques in applications that are so large (from terabytes to exabytes) and complex (from sensor to social media data) that they require advanced and unique data storage, management, analysis, and visualization technologies.*” As organizations have begun collecting vast amounts of structured and unstructured data from diverse sources such as operational databases, server logs, sensors, social media and web crawlers, the challenges associated with managing and analyzing that data have become formidable.

These challenges typically correspond to the “3 V’s” – *volume*, *velocity* and *variety* – the defining characteristics of big data first identified by Laney in 2001. *Volume* refers to the massive amount of data that is available and must be handled. *Velocity* encompasses not only the need to capture and store data arriving at or near real-time, but also the ability to quickly unearth meaningful information from that data [23]. *Variety* signifies the diversity of formats and heterogeneous semantics of data arriving from different sources. Moreover, these challenges highlight the need to assimilate and understand data within the context of a given situation [5]. Beyond the “3 V’s,” there are also challenges associated with *veracity* (keeping the data as clean and free of biases and abnormalities as possible), *validity* (assessing whether the data is accurate and appropriate for the intended use) and *volatility* (deciding when data is no longer relevant and thus how long it should be stored) [32].

In all likelihood, organizations’ ability to grow and perform in the era of big data will be hampered by a lack of appropriate talent. Manyika et al. [29] estimate the shortage of workers with deep analytical skills in United States alone will approach 190,000 by the year 2018. Worse yet, they predict a shortage of up to 1.5 million managers and analysts with the ability to analyze big data and utilize the results to make effective decisions.

The purpose of this paper is to investigate knowledge, skills and abilities that will be expected of big data professionals by developing a survey instrument that can be used to assess the relative importance of various KSAs. The results of this study will be helpful in developing strategies within academia and industry to address the big data talent gap.

LITERATURE REVIEW

Skills Studies in IS/IT

The literature on the knowledge, skills, and abilities (KSAs) expected of IT professionals is one of the more robust research streams with respect to the IT workforce. Early work was primarily concerned with identifying the skills that were possessed by IT professionals and those that were most important in helping them do their jobs. Some of this work examines and compares viewpoints of various stakeholders (IT workers, managers, users, etc.). Later work extends the body of research via longitudinal studies aimed at determining how skill sets have changed over time. In some cases, researchers take a very different perspective such as examining the relationship between perceived capabilities of IT workers and aspects of IT infrastructure flexibility and competitive advantage afforded by IT [10] [22] [38].

The literature investigating which of a set of KSAs is most important to the IT professional is extensive. The most common method of conducting this research is to develop a list of KSAs that are expected to be relevant to a group of IT professionals and to survey either the IT professionals themselves or some other stakeholder group as to the importance of each. In some cases, structured interviews supplement (or replace) traditional surveys.

Some KSA studies take a narrow focus on the skill sets included; for example, looking only at technical skills (e.g., [12] [21]) or only at business or communications skills (e.g., [9] [7]). Others have taken a broader focus and included KSAs grouped into categories such as technical skills, technology management skills, business/functional skills, and interpersonal/communications skills (e.g. [39] [27] [36] [18]).

Regardless of the source from which the importance ranking is solicited – the IT professional, IT managers, users, or academics – these studies commonly find that business/functional and interpersonal/communications skills are considered to be more important than the more technically-oriented skills.

The era of big data ushers in a host of new technologies, applications and opportunities for improving organization performance. This change, coupled with the shortage of individuals who can analyze big data and make decisions based on their findings, suggests there is a pressing need to identify the KSAs required for big data professionals and to develop academic programs that produce graduates capable of filling those roles. The extension to big data knowledge and skills represents a contribution to the KSA body of research.

Skills from the Big Data & Data Science Literature

Despite the extensive body of literature on KSAs required of IT professionals, we have found few empirical studies examining necessary skills in the area of big data. One study [4] reviewed the broader big data literature to compile an initial set of skills (shown in Table 1, below) against which to compare academic course offerings in big data programs. This study identified both relevant technical skills and non-technical skills including communication, ethics, and decision making.

TABLE 1: Skills identified in [4]

| Skill/Topic Area and Definition Used | Abbreviation | Citations |
|--|---------------------|------------------------|
| Mathematics/statistics/probability <i>Coverage of mathematics, statistical techniques (including hypothesis testing and regression) and/or probability</i> | MS | [11] [14] [29] [17] |
| Data mining techniques <i>Coverage of data mining techniques including classification, text and web mining, stream mining, knowledge discovery, anomaly detection, associations, and other techniques</i> | DMIN | [11] [29] [17] |
| Other modeling/analytics techniques <i>Coverage of analytical/quantitative techniques such as</i> | OMA | [29] [17] |

| | | |
|--|------|------------------------------------|
| <i>machine learning, neural networks, decision trees, linear programming, integer programming, goal programming, queuing, etc.</i> | | |
| Visualization techniques <i>Coverage of the visual presentation of data</i> | VIS | [29] |
| Programming skills <i>Coverage of computer programming skills</i> | PROG | [14] |
| Data management <i>Coverage of data management topics including SQL, data models, and entity-relationship diagrams</i> | DMGT | [11] [25] [8] |
| Understanding of big/ unstructured data <i>Coverage of topics related to very large data sets. May include mention of unstructured data, variety, or velocity</i> | BIG | [29] [25] |
| Data capture techniques/technologies <i>Coverage of topics related to the storage of data; includes distributed storage technologies such as Hadoop</i> | CAP | [29] [8] [17] |
| Data storage techniques/technologies <i>Coverage of topics related to data acquisition or collection</i> | STOR | [11] [29] [35] [8] |
| Data security <i>Coverage of data security issues</i> | SEC | [29] [8] |
| Data preparation/quality <i>Coverage of data cleaning, data preparation and data quality</i> | PREP | [8] |
| Ethical considerations <i>Coverage of topics related to ethical use of data and/or confidentiality</i> | ETH | [31] [37] [40] [34] [29] [8] |
| Data governance policies <i>Coverage of data governance issues including decision rights, accountability, and/or use of data</i> | GOV | [37] [29] [8] |
| Decision making skills <i>Coverage of tools/techniques for decision making and/or decision making process</i> | DEC | [26] [29] |
| Communication skills <i>Coverage of or practice with communication skills; may include presentation of project results or reports</i> | COMM | [24] |
| Case studies <i>Use of case studies within a course</i> | CASE | Not applicable |
| Evaluation <i>Evaluate applicability of tools or techniques for a given problem. May include topics such as alignment of organizational strategy or goals</i> | EVAL | Not applicable |

In another study, Debortoli, Muller and vom Brocke [15] reviewed online big data job advertisements and identified relevant skills in both technical and business areas. This study identified the expected technical skills including knowledge of both traditional and NoSQL databases, programming, and quantitative analysis, and machine learning algorithms. Software

engineering and software testing also emerged as relevant skills sets. Consistent with findings from the IT workforce KSA literature, this study also found mention of a number of business skills. These include both managerially-oriented skills in the areas of new business startup, sales, and business development, as well as domain specific skills in the areas in which big data is being utilized including the life sciences, sales, and digital marketing [15].

In addition to the traditional academic literature, there are a number of industry trade publications and academic and industry white papers discussing implications of big data as well as necessary skills for its use. Although a full review of these resources is beyond the scope of this article, they contain a number of useful insights into relevant big data skills beyond those already discussed. For example, organizations will seek to use and integrate data from multiple diverse sources both structured and unstructured. As Davenport points out in the forward to a NewVantage Partners report, “. . . integration will continue to be one of the greatest challenges faced by IT organizations” [14, p. 1]. Additionally, technically-oriented big data professionals will need to partner with business users to help interpret findings thus requiring knowledge of end-user reporting tools such as dashboards [19]. Finally, soft skills continue to be an underlying theme across much of the literature including trade publications. In addition to good communication skills and the ability to determine how to apply analytical skills to specific business problems, many employers seek to hire talented people with general problem solving skills that might be applied across a wide range of situations [30].

This literature review has identified a wide range of necessary skills both for IS and IT professionals as well as for those in the big data area. In the following section, we describe the creation of a survey instrument designed to assess the importance of those skills to potential employers.

METHODOLOGY

The purpose of this study is to develop a survey instrument to assess what skills are the most important to industry and academics in the area of big data and data science. To this end, we have developed an initial list by compiling skills previously identified in the IT/IS field and skills found in the big data literature discussed above. The skills found from the literature are summarized in Table 2. Table 2 is an extension of the work done by [4].

The KSAs found in [1] and [2] were used as a starting point for this survey. Technical skills (such as networking) that were considered to be specific to the IT field were eliminated and replaced by the big data and data science KSAs identified in Table 2. Also, experience and GPA from the initial studies were eliminated as these characteristics were found to have the least importance. Moreover, we included organizational and managerial skills as they may be more important in the big data/data science arena given the increased importance of understanding the domain of the data problem being solved [15]. The resulting list of skills to be included in the survey are shown in Table 3. The first section contain the top twelve KSAs found in the previous studies in the order ranked by respondents in the survey and the second section contains the organizational and managerial KSAs.

TABLE 2: Knowledge and skills related to data identified in the literature

| Knowledge or Skill | Reference from Literature |
|---|----------------------------------|
| Analytics techniques | [29] [17] [6] [3] |
| Big/ unstructured data | [29] [25] [3] |
| Business intelligence (reporting, OLAP cubes) | [6] |
| Data capture techniques/technologies | [29] [8] [17] |
| Data governance policies | [37] [29] [8] |
| Data integration | [33] [6] |
| Data mining techniques | [11] [29] [17] [3] |
| Data preparation/quality | [8] |
| Data security | [29] [8] |
| Data storage techniques/technologies | [11] [29] [35] [8] |
| Data warehousing | [3] |
| Database/data management skills (traditional) | [11] [25] [8] [3] [33] |
| Decision making skills | [26] [29] |
| Ethical considerations | [31] [37] [40] [34] [29] [8] |
| General problem solving | [30] |
| Knowledge of applications | [6] |
| Machine learning | [33] |
| Mathematics/statistics/probability | [11] [14] [29] [17] [6] [3] |
| Programming skills | [14] [3] |
| Visualization techniques | [29] [3] |

TABLE 3: Ranked knowledge, skills and traits from [1] and [2]

| Top 12 KSAs |
|---|
| Honesty/integrity |
| Attitude |
| Willingness to learn new skills |
| Communication skills (oral and written) |
| Analytical skills |
| Professionalism |
| Ability to work in teams |
| Flexibility/adaptability |
| Motivation |
| Interpersonal skills |
| Creative thinking |
| Organizational skills |
| Organizational and managerial KSAs |
| Knowledge of primary business functions |
| Project management skills |
| Knowledge of your company |
| Knowledge of specific industry |
| Leadership skills |

The survey will consist of the combined KSAs provided in Tables 2 and 3 and will be ranked by academicians and people in industry on a five point Likert scale ranging from not important to very important for big data and data science workers.

DISCUSSION AND FUTURE RESEARCH

Building upon prior research into the KSAs required of IT professionals, this paper takes an important step towards developing a general-purpose instrument that can be used to gauge the skills most important to industry and academics in the areas of big data and data science. The underlying logic is that big data and data science IT professionals - as a sub-group of IT professionals dealing with emerging and more strategic information technologies - may require a different blend and set of KSAs to that of more general IT professionals. While the actual level of distinctiveness in KSAs for big data and data science IT professionals remains an empirical question, the next stage of this research is to pretrial the instrument across a sample of academic and industrial groups, and then move to a larger distribution of the instrument. In distributing this instrument to both academic and industry groups, our hope is to provide a deeper understanding – based on empirical responses – of any perceptual gaps between industry and academia, and in doing so, better inform future academic curriculum initiatives within these areas.

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SIMULATING A DISASTER RELIEF SUPPLY CHAIN THROUGH CASE STUDY

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ABSTRACT

Recent natural and man-made disasters underscore the need of a better disaster relief supply chain to mitigate the damages and reduce casualties. In this study, we design and develop a simulation model of the disaster relief supply chain using Arena. The disaster relief supply chain we considered consists of four stages: Point of Distribution (POD), State Staging Area (SSA), Federal Operations Staging Area (FOSA), and Logistic Centers. At the PODs, SSA, and FOSA stages, (r, Q) continuous review inventory policy is used to control the inventory. The main performance measures include coverage rate, total inventory costs, inventory level, backorder level, and lost demand. The developed simulation model is evaluated through a case study applied to an imaginary nuclear disaster in South Carolina. The computational results illustrate the impact of increased demand and inventory pre-position on the main performance measures.

Keywords: Disaster Relief Supply Chain, Simulation modeling, Arena Simulation Software, Case Study

1. INTRODUCTION

Disaster normally refers to a natural and inevitable event such as tornado, hurricane, tsunami, and earthquake. Disaster may also be caused by human activities such as the Sarin attack in the Tokyo Subway in 1995, Chernobyl nuclear accident in 1986, and Fukushima Daiichi nuclear disaster in 2011. Recent deadly disasters (e.g. the September 11 attacks in 2001, Hurricane Katrina in 2005, Haiti earthquakes in 2010, and tsunami and earthquake in Japan in 2011) cause tremendous property loss and casualty. Some researchers such as [1, 2, 3] reported that natural disasters are increasing in frequency and intensity in the last ten years due to several reasons such as quickly growing population, larger concentration in high-risk areas, and increasing social and economic interdependency. To better prepare for these increasing disasters, it is very crucial to design and develop a resilient and agile disaster relief supply chain to reduce casualties and mitigate the damages immediately after disaster occurs. A well designed disaster relief supply chain can supply and distribute the essential commodities such as water, meals, blanket, tarps, medicine, etc. to millions of disaster victims in a short period time. Therefore, developing a better disaster relief supply chain is essential and immediately needed.

According to FEMA's disaster relief supply chain structure, a typical disaster relief supply chain starts from suppliers of federal and local government or private donors to Federal Staging Area (FOSA), to State Staging Area (SSA), and finally to the Point of Distribution (POD) as illustrated in Figure 1 [4]. The disaster relief supply chain differs from traditional commercial supply chains

from different aspects such as a huge surge of sudden demand, damaged transportation network, demand uncertainty of victims, crippled communication infrastructure, short lead times, and many other uncertainties. Nevertheless, there are lessons that can be borrowed from the well-studied commercial supply chains and vice versa.

The main purpose of this study is to develop a simulation model to evaluate the performance of the disaster relief supply chain through case study. The performance measures includes the coverage rate, inventory related costs, inventory level, and backorder level. This research also evaluates the impact of increased demand and inventory pre-position on the main performance measures.

The organization of this paper is as follows. In Section 2, we conduct a brief literature review that surveys the related studies on simulation modeling of disaster relief supply chain. Section 3 introduces a simulation model that is designed and implemented using Arena Simulation Software. In Section 4, we perform a computational case study based on the developed simulation model and discuss the model results. Section 5 summarizes our research findings and layout the possible future research.

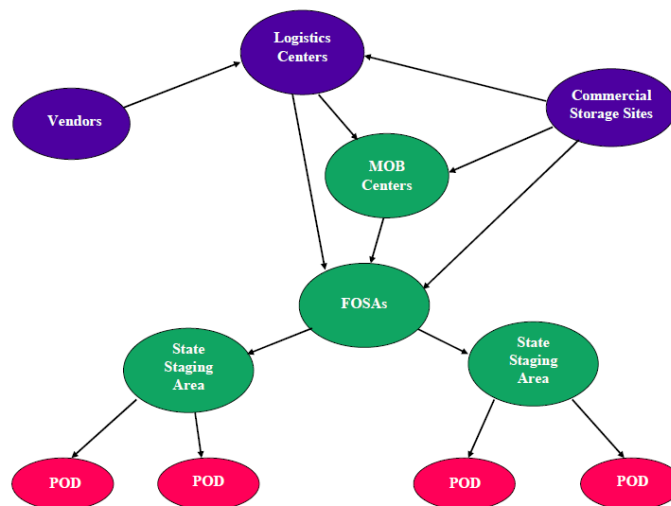


Figure 1 FEMA's Disaster Relief Supply Chain Structure

2. BRIEF LITERATURE REVIEW

According to [5], a simulation model for disaster relief is the foundation on which new policies and tactics can be developed and evaluated. In order to develop decision-making tools for disaster relief supply chain, simulation can be an excellent tool for understanding the impact of disasters, disaster relief operations, and the consequences of alternative policies. Simulation models also serve as a test bed as real-life experimentation of analytical tools with actual disaster situations would be too difficult and risky.

Various simulation models have been developed for disaster relief supply chain in response to different types of disasters. Several researchers used simulation models to design and evaluate disaster relief supply chains (see [6, 7, 8]). For distribution operations of disaster relief goods, a

number of studies investigated various issues about the disaster relief supply chain (see [9, 10, 11, 12, 13, 14]). This study focuses on the disaster relief distribution operations using FEMA’s logistic supply chain model in case of a nuclear disaster.

3. SIMULATION MODEL DESCRIPTION AND DEVELOPMENT

In this study we develop a simulation model for disaster relief supply chain. The model consists of four linked stages: Points of Distribution (PODs), State Staging Areas (SSA), Federal Operations Staging Areas (FOSA), and Logistic Center (LC). The system is briefly depicted in Figure 2.

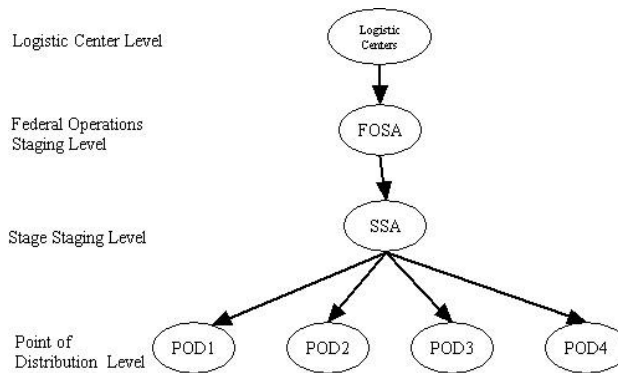


Figure 2 Disaster Relief Supply Chain System

In Figure 2, the victim demands for disaster relief supplies starts from PODs. Disaster victims arrive at a POD, receive the supply, and leave. The POD use a continuous review (r, Q) inventory control policy to manage the inventory, where the Q represents order quantity and r represent reorder point. Under this policy, whenever the inventory position (inventory on-hand plus outstanding orders minus backorders) reach the level r or below, a replenishment of quantity Q is ordered from the SSA. Note that in Figure 3 there are four PODs, each of which can have its own r and Q values. If the SSA has sufficient inventory available, the order from PODs will be fulfilled and transported to POD by trucks with a transportation lead time. If the on-hand inventory at a POD can’t satisfy the victim demand, the demand is lost. The demand stream at SSA consists of orders from the PODs. Unlike the POD stage, the unsatisfied demand at SSA is backordered. The SSA replenishes its inventory from FOSA based on the same (r, Q) continuous review inventory policy. If the FOSA has enough on-hand inventory, the order from SSA will be satisfied and transported to SSA with a transportation lead time. Otherwise, the unsatisfied demand at FOSA will also be backordered. Similarly, the FOSA also use a (r, Q) inventory policy to control its inventory. The FOSA replenishes its inventory from a supplier with unlimited stock and 100% guarantee of order fulfillment. The order delivered from the supplier to the FOSA takes a positive transportation lead time.

In this paper we developed our simulation model using Arena Simulation software. The simulation model consists of four sub-models: POD sub-model, SSA sub-model, FOSA sub-model, and Logistics Center sub-model. Each sub-model is subjected to the following events: demand arrival, inventory updating, replenishment order triggering, and order shipment and receiving. These sub-models are interconnected with ordering signals. When inventory position of a certain stage is at or below the reorder point, an ordering signal is sent to the upper stream stage and activates the

replenishment order processes at the upper stream stage. In the following sections, we will briefly describe each sub-model, starting from downstream PODs to upstream supplier. Figure 3 shows the snapshot of the Arena simulation model for disaster relief supply chain.

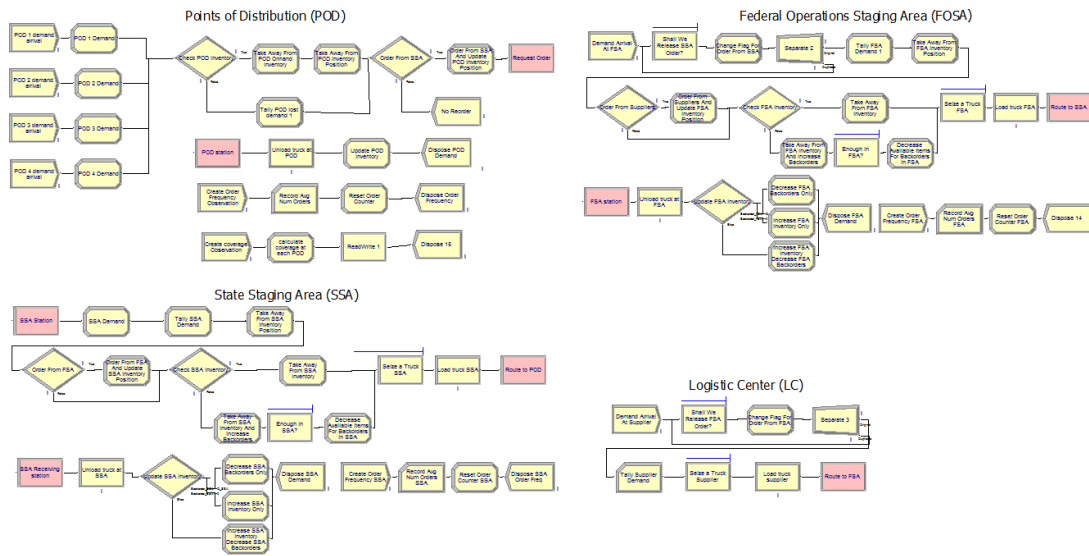


Figure 3 Arena Model of the Disaster Relief Supply Chain

- (1) **POD sub-model:** The model starts with the generation of victim demand. The demand generation is according to Poisson process (Since Poisson process is commonly used for demand generation, we employ it for our preliminary study. When the real inter-arrival time data is available for a disaster relief operation, demand can be generated according to the actual data.) The sub-model then proceeds to test whether the POD has sufficient on-hand inventory. If POD has enough inventory, the demand is satisfied, the on-hand inventory is decreased by the demand quantity, and inventory position is updated accordingly. Otherwise, the victim demand is lost and the total cumulative lost demand is recorded for each POD. If the inventory position at a POD down-crosses its reorder point, the POD sends an ordering information to SSA and SSA starts to process the order. In the meantime, the inventory position of the POD will be increased by order quantity immediately. When the order is satisfied and arrived at the POD receiving station, the order will be unloaded from truck and on-hand inventory is updated.
- (2) **SSA sub-model:** This sub-model receives the orders from PODs, updates the SSA inventory levels, triggers replenishment orders from the FOSA, receive orders from FOSA, and send fulfilled orders to the PODs. When a POD order arrives at SSA, the demand information is recorded and then the inventory position of SSA is decremented by the POD order amount. Then, the sub-model checks whether the SSA inventory position down-crosses its reorder point. If so, the sub-model sends an order request to FOSA and increases its inventory position by order amount. The sub-model then checks if SSA has sufficient inventory to satisfy the POD order. If it has, the order is satisfied from the on-hand inventory and the inventory level is updated. If not, the POD order is not fully satisfied and backordered from the SSA. When a replenishment order is received from FOSA, backorder

is satisfied with priority. The POD order is now ready for shipment to the POD. The POD order will be uploaded to a truck and shipped to the receiving station of the PODs.

(3) **FOSA sub-model:** The logic of this stage is identical to the SSA stage. This stage receives and processes the orders from SSA, updates FOSA inventory levels, orders and receives replenishment stocks from supplier, and sends shipment to SSA. Because the processes are the same as the SSA stage, we don't repeat the processes.

(4) **Logistic Center sub-model:** This sub-model process FOSA orders, loads the supplies to trucks, and sends shipment from the logistic center to FOSA stage. The logic of generating FOSA orders to supplier is identical to the generation logic used in the FOSA stage. We assume that logistic center is 100% reliable with unlimited capacity. Because the logistic center always has sufficient supplies to fulfill the FOSA orders, the replenishment delays only include transportation delay (lead time).

4. COMPUTATIONAL CASE STUDY

To evaluate the performance of the simulation model, we conduct a computational case study for an imaginary nuclear disaster. We assume that the Virgil C. summer nuclear power plant located approximately 20 miles northwest of Columbia, SC has a nuclear disaster and the residents within 15 miles of the power plant need to evacuate to the designated PODs for relief supplies. The nuclear disaster could be caused by natural disasters (e.g. earthquake, hurricane, or tornado) or man-made disasters (e.g. terror attacks). For this study, 1 LC in Atlanta, GA, 1 FOSA in Augusta, GA, 1 SSA in Columbia, SC, and 4 designated PODs in White Oak conference center, Dutch Fork high school, Crossroads middle school, and Newberry high school are activated.

In this setting, we model the distribution of two key relief goods: water and MRE. The distribution package for each victim per day contains 3 liter water and 2 MREs. At each POD, victims typically arrive by car and the number of victims in a car is given by a discrete probability distribution, DISC (0.05, 1, 0.25, 2, 0.7, 3, 0.95, 4, 1.0, 5) with average of 3 victims. The simulation simulates 5 days of distribution operations. Table 1 shows the pre-positioned supply at supply chain stages for the base case. Note that the temporary distribution facilities such as SSA and PODs usually have no previously stocked inventory when disaster happened.

Table 1 Pre-positioned Supplies at Supply Chain Stages for Base Case

| Supply chain stage | Water and MRE package |
|--------------------|-----------------------|
| LC | unlimited |
| FOSA | 10,000 |
| SSA | 0 |
| PODs | 0 |

For this computational case study, we make the following assumptions:

- If a victim arrives at a POD and there are no supplies, then the demand is lost.
- Unsatisfied demands can only be backordered at SSA and FOSA stages.

- There are no capacity restriction for inventory storage at each stage of the supply chain
- Disaster relief orders start from PODs and sequentially travel to upstream of the supply chain (e.g. POD order cannot be requested from FOSA or Suppliers directly).
- Transportation mode is trucking only. The transportation lead time is triangular distributed.
- Orders will be delivered from SSA to each POD directly. The orders of multiple PODs cannot be combined and delivered with one truck route.
- Inventory control parameters are not changed as the demand rate changes.

We list the model input parameters as follows:

Table 2 displays the values of the Model's demand parameters at PODs. The expected demand is estimated based on the 2010 population census data. The demand inter-arrival time is exponentially distributed with a parameter x , $EXP(x)$. Because the expected demand varies among PODs, each POD has the different inter-arrival time for the base case simulation. We assume that the demand quantity at each POD follows the same discrete probability distribution, DISC (0.05, 1, 0.25, 2, 0.7, 3, 0.95, 4, 1.0, 5).

Table 2 Demand Parameters at Pods

| Demand parameters | POD1 | POD2 | POD3 | POD4 |
|-------------------------------------|-------------|-------------|-------------|-------------|
| Expected Demand | 13563 | 16682 | 32717 | 19140 |
| Demand Inter-arrival Time (Seconds) | EXP (20) | EXP (16) | EXP (8) | EXP (14) |
| Demand Quantity Q | Discrete | Discrete | Discrete | Discrete |

Table 3 displays the values of the Model's inventory control parameters and the initial inventory level. These parameter values are calculated based on the continuous review inventory formulas from [15].

Table 3 Inventory Control Parameters

| Inventory Parameters | POD1 | POD2 | POD3 | POD4 | SSA | FOSA |
|-----------------------------|-------------|-------------|-------------|-------------|------------|-------------|
| Reorder Point R | 565 | 695 | 1363 | 798 | 21582 | 21582 |
| Order Quantity Q | 4450 | 6911 | 6911 | 5286 | 21582 | 21582 |
| Initial On-hand Inventory | 0 | 0 | 0 | 0 | 0 | 10000 |

Additionally, the transportation lead time are assumed to follow triangular distribution. We assume that the transportation lead times from SSA to POD is TRIA (30, 45, 60) minutes and from FOSA to SSA are TRIA (60, 75, 90) minutes. The lead time from Supplier to FOSA is TRIA (120, 135, 150) minutes. The truck loading and unloading time between each stage is normally distributed as Normal (10, 0.1) minutes.

Base Case Simulation Results: The Performance metrics we used for this study are coverage rate (service level), inventory measures, and inventory related costs. Typically 95% coverage should be reached within three days from the start of disaster. Ideally 100% coverage should be reached. But in reality, the coverage rate can't reach 95% for various reasons. Figure 4 shows the coverage rate for each POD for the first five days of relief operations. We notice that the coverage curves at

the four PODs have the same upward trends. They all start with about 70% and approach 95% at the end of day 5. However, none of the POD reaches 95% for the base case.

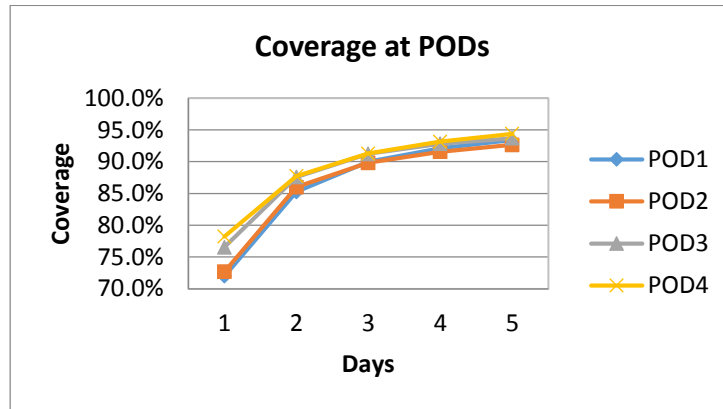


Figure 4 Coverage at PODs for Base Case

Table 4 shows the inventory measures at each stage of the disaster relief supply chain for base case. From this table, we notice that both inventory level and total inventory related costs increase as we travel up to the upstream supply chain. SSA has the highest coverage rate, whereas FOSA has the lowest coverage rate. Among the three inventory cost components, holding costs are the highest. That infers that in order to maintain higher coverage rate, we have to maintain higher inventory level to cover more demand.

Table 4 Inventory Information at each Stage for Base Case

| | Inventory level | Backorder level | Lost Demand | Coverage (%) | Ordering Costs | Holding Costs | Backorder Costs | Total Costs |
|-------------|-----------------|-----------------|-------------|--------------|----------------|---------------|-----------------|-------------|
| POD1 | 2102.5 | N/A | 1242.8 | 93.4% | 1750 | 257079.8 | N/A | 258829.8 |
| POD2 | 2341.7 | N/A | 1595.9 | 92.6% | | | | |
| POD3 | 3305.8 | N/A | 2793.2 | 93.7% | | | | |
| POD4 | 2533.2 | N/A | 1514.3 | 94.4% | | | | |
| SSA | 25387.6 | 753.6 | N/A | 94.5% | 500 | 634689 | 18839.9 | 654028.9 |
| FOSA | 31551.2 | 1420.8 | N/A | 85.0% | 275 | 788779 | 35519.8 | 824573.8 |
| Total Costs | | | | | 2525 | 1680547.8 | 54359.7 | 1737432.5 |

Increased Victim Demand Case: In this scenario, we simulate the impact of more demand on the coverage and inventory measures. We increase the demand listed in Table 2 by 20%. As expected, more victim demand results in deteriorated coverage and inventory measures. In Figure 5, we observe that the coverage rate is lower than that in base case for each day of the operations. On day 5, most of PODs end up with 91%. Comparing with the coverage rate in Figure 4, the coverage rate decreased by 2.7%. In Table 5, we observe the same result pattern mentioned in Table 4. We also notice that comparing with Table 4, inventory levels decrease, lost demands at PODs increase,

coverage rates decrease. This experiment illustrates that increased demand has a significant adverse impact on coverage rate and inventory measures.

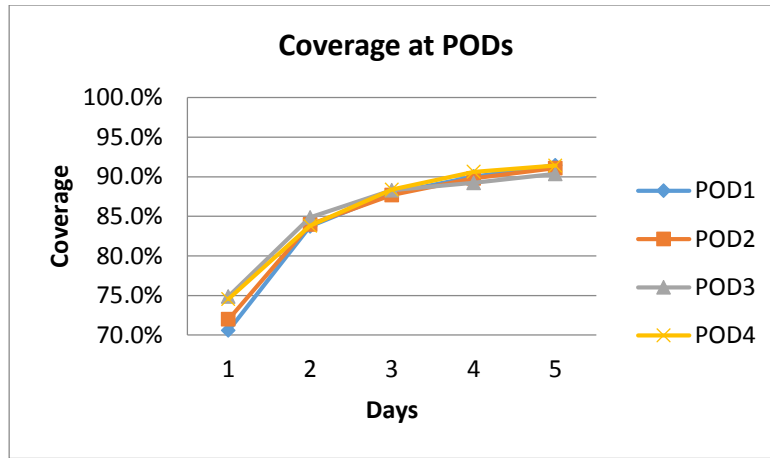


Figure 5 Coverage at PODs for Increased Demand Case

Table 5 Inventory Information at each Stage for Increased Demand Case

| | Inventory level | Backorder level | Lost Demand | Coverage (%) | Ordering Costs | Holding Costs | Backorder Costs | Total Costs |
|-------------|-----------------|-----------------|-------------|--------------|----------------|---------------|-----------------|-------------|
| POD1 | 2047.5 | N/A | 1791.1 | 91.4% | 2025 | 247452.8 | N/A | 249477.8 |
| POD2 | 2280.7 | N/A | 2253.6 | 91.1% | | | | |
| POD3 | 3140.1 | N/A | 4114.5 | 90.4% | | | | |
| POD4 | 2429.8 | N/A | 2250.6 | 91.4% | | | | |
| SSA | 25663.2 | 721.6 | N/A | 95.2% | 550.0 | 641580.4 | 18040.5 | 660170.9 |
| FOSA | 30988.3 | 1387.7 | N/A | 86.4% | 300.0 | 788779.0 | 34693.4 | 823772.4 |
| Total Costs | | | | | 2875.0 | 1677812.2 | 52733.9 | 1733421.1 |

Pre-Positioning Inventory Case: The base case shows that coverage rate at each POD approaches 95% on day 5. In this case, we plan to study if we stock up more inventory along the supply chain where we should put them and what is the impact on coverage rate. First, we double the initial inventory at FOSA (increasing 10,000 packages) and observe no changes on coverage rate. Then, we add 10,000 packages at SSA and observe significant improvement of coverage rate. Table 6 shows that after stocking up more inventory at SSA, the coverage rate at each POD reaches 95% on day 2 or day 3. This experiment demonstrates that increasing supplies at upstream supply chain does not improve coverage, whereas increasing supplies at downstream supply chain may significantly improve coverage. This indicates that it is crucial to supply more stocks in the downstream supply chain such as SSA and POD as soon as possible after the disaster starts.

Table 6 Comparison of Coverage for Pre-Positioning Inventory Case

| Days | Increase 10,000 packages at FOSA | | | | Increase 10,000 packages at SSA | | | |
|------|----------------------------------|------|------|------|---------------------------------|------|------|------|
| | POD1 | POD2 | POD3 | POD4 | POD1 | POD2 | POD3 | POD4 |
| | | | | | | | | |

| | | | | | | | | |
|---|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 | 72.0% | 72.7% | 76.5% | 78.2% | 90.8% | 90.4% | 92.4% | 95.7% |
| 2 | 85.2% | 86.0% | 87.6% | 87.7% | 94.0% | 94.9% | 95.5% | 97.6% |
| 3 | 90.0% | 89.8% | 91.2% | 91.3% | 95.5% | 95.9% | 95.8% | 98.0% |
| 4 | 92.1% | 91.6% | 92.8% | 93.1% | 95.9% | 96.5% | 96.6% | 98.3% |
| 5 | 93.4% | 92.7% | 93.7% | 94.4% | 96.7% | 96.6% | 96.8% | 98.3% |

5. SUMMARY AND FUTURE WORK

In this study, a simulation model of the disaster relief supply chain has been designed and developed using Arena simulation software. The simulation model considers the key processes of the disaster relief supply chain, such as POD processes, SSA processes, FOSA processes, and Logistic Center processes. The victim demand is randomly generated with different demand quantity at each POD. The supply of disaster relief goods are assumed unlimited and 100% reliable at the logistic center stage. At the PODs, SSA, and FOSA stage, (r, Q) inventory policy is used to control the inventory. The main performance measures include total inventory costs, inventory level, backorder level, lost demand, and coverage rate. The developed simulation model is evaluated through a preliminary computational case study. This computation study evaluates the impact of increased demand and inventory pre-position on main performance measures. The future work we considered is as follows. First, a dynamic optimization process should be considered to optimize the inventory parameters during the simulation process. Second, other factors, such as transportation distance, transportation costs, and transportation routing may be incorporated into the simulation model. Third, the impact of input change (e.g. demand uncertainty and supply uncertainty) on the system performance needs to be addressed.

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EVALUATING REQUIRED INFORMATION TECHNOLOGY JOB SKILLS

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ABSTRACT

Almost all organizations today depend upon the information technology for nearly all aspects of their business. Information technology involves multiple components and its complexity has only increased in last few years. There is a need today to improve IT curriculum at various education levels to meet the modern day challenges. Authors in this paper explore the ways in which educational institutions can provide the necessary skills to future IT employees.

There is no doubt that pace of technological changes has been accelerating throughout this century, therefore the college curricula have been struggling to provide the skills and training needed at the fast changing workplace. A major inflection point occurred in IT area before the turn of the century when its role changed from back office support to a strategic component of the business strategy. With that, and with the rise of the Internet/World Wide Web, the need for IT skills increased tremendously. There is a need today to improve curriculum at various education levels to meet the modern day challenges. Instead of performing just the routine tasks of help-desk and support, IT employees today help achieve the organizational goals [2]. Lee and Han [2] analyzed the gaps between the IS 2002 model curriculum and the industry requirements in the Fortune 500 companies and suggested that knowledge of technological trends, knowledge

of business functions and general problem solving skills be taken into account by the IS/IT curricula developers.

Most organizations today depend upon the technology for virtually all aspects of business. Information systems/technology involves multiple components that have only increased in last few years, these components fall into categories of hardware, software, data, and procedures, in addition to the users. This set of components requires that an IT employee to have a broad spectrum of possible skills to be competitive in the workforce. According to a CompTIA report published in 2012, more than 15 million businesses rate the skill levels of their IT staff as below optimal. In its *2012 State of the IT Skills Gap report*, the computing technology association cites the top industry skills gap areas to include network infrastructure, server and data center management, storage and data back-up, cyber security, database and information management, and web design/development. The dynamic nature of the IT field is a primary cause of talent shortages, as the employee skills become outdated rather quickly. Additionally, organizations due to competitive pressure, recession and other reasons are not able to provide resources for continual professional development to its employees. In addition to technical skills, it has been suggested in the past the significance of communication and business skills on the part of IT employees [3].

In the world-wide survey, about 93% of respondents indicated a skills gap, defined as the difference between existing and desired IT skill levels of the IT staff [1]. Also, by 2020, employment in all computing occupations is to increase by 22% based on the Bureau of Labor Statistics (BLS) report [5]. This indicates a need for a concerted effort by academia and industry to increase the likelihood that future IT employees will have the skills needed.

The objective of this proposed study is two-fold, the first purpose is to evaluate the current needs of IT employee skills as identified by managers and employers. This would be followed by identifying the ways in which educational institutions can provide the necessary skills to future IT employees. Since the purpose of the research is to provide data that employers and educators can use to better prepare graduates and develop the needed skill sets to fill IT skills gaps, the researchers would use a mixed qualitative and quantitative approach.

At the initial stage of the research, the focus would be on the IT organizations and job market in Metro Atlanta area. The Metro Atlanta area ranks sixth in the nation when it comes of information technology jobs [4], with numerous businesses needing modern IT skills. This would then be followed by determining ways in which educational institutions can provide the necessary skills to future IT employees. The researchers would begin by interviewing the employers, academicians and college alumni regarding the current set of skills that each graduating college student should have to succeed in today's IT market. Once a set of skills has been identified, using a survey, the researcher would solicit opinions of managers concerning the importance and significance of each skill. Some of the skills may be absolutely essential for graduates while others can be learned on the job, with experience. It is expected that the knowledge gained from the employer feedback would help plan out the curriculum. Some of the questions to be answered include: is there a need for developing skills to be a specialized IT employee (networking, software development, enterprise resource, etc.), how much, and what type, of the business skills and knowledge is important to have for IT graduates, how important are the skills to interact with customers and end-users, and how important are soft-skills to employers.

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Knowledge, Skills and Abilities in Supply Chain Management: a Human Capital Theory
Perspective

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Abstract: Supply Chain Management is a rapidly evolving field where the roles and responsibilities for professional managers are constantly changing. Extended supply chains and new technology have increased the job complexity for many of today's SCM professionals. To examine these new responsibilities and required skills I analyze 1,390 SCM advertised positions posted on Monster.com®. Themes derived from computerized manifest text analysis reveal thirty-eight skill-sets of which sixteen influence the salaries posted for these positions. The results have implications for managers attempting find and retain SCM talent, academics identifying areas of inquiry, and for creating and updating operations and supply chain pedagogy.

REDUCING PHLEBOTOMIST WORK OVERLOAD IN HOSPITAL LABORATORIES USING A BLOOD DRAW ASSIGNMENT MODEL

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ABSTRACT

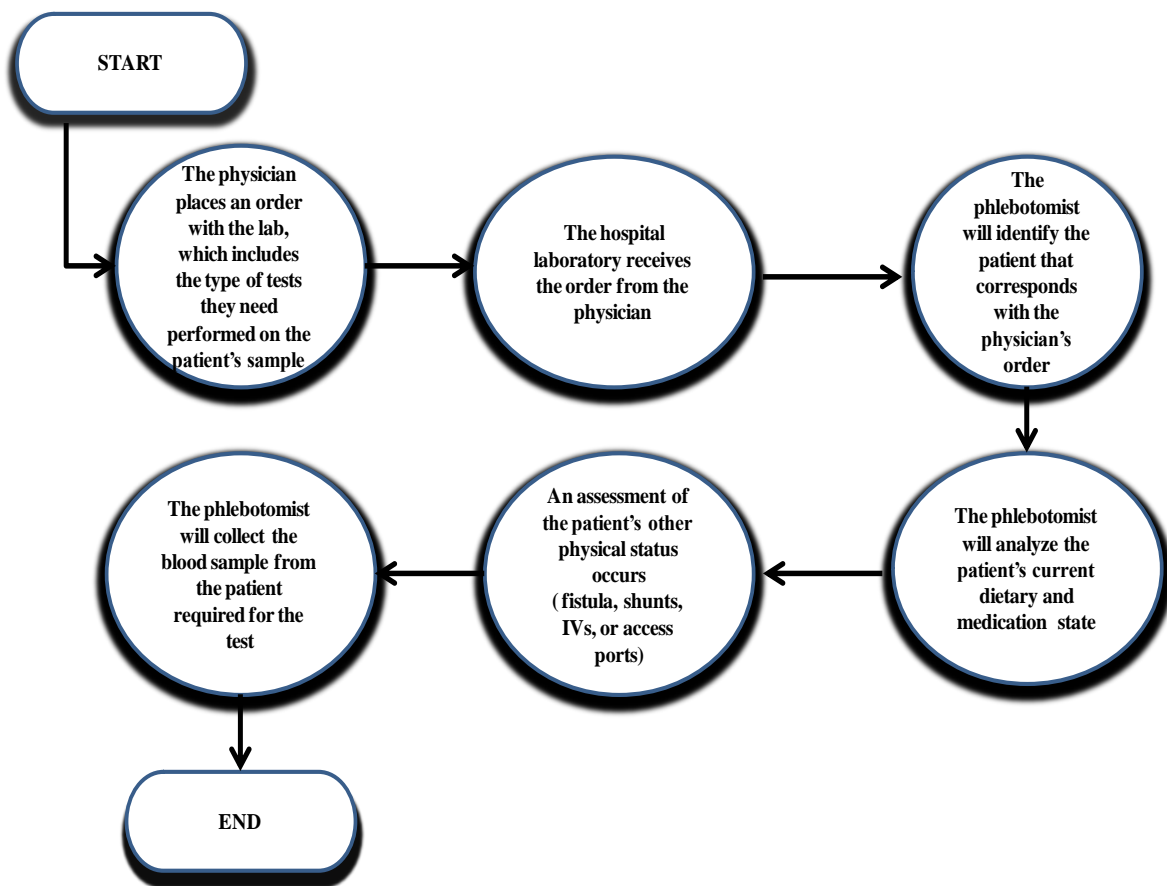
Laboratory services in healthcare delivery systems play a vital role in inpatient care. Laboratory testing alone accounts for approximately 10% of hospital billing. A goal for the U.S managed healthcare delivery system is to considerably reduce laboratory costs associated with staff error caused by work overload. To aid in achieving this goal, this research study focuses on the optimization of blood draw assignments in hospital laboratories. To minimize work overload, Excel Modeling is utilized to determine the optimal number of blood draws assignments for each phlebotomist. From reducing work overload, phlebotomist errors should reduce as well, which could achieve significant cost savings for healthcare delivery systems. The final results of the blood draw assignment model indicate the number of blood collections to be assigned to each phlebotomist to balance workload within and between shifts.

INTRODUCTION

Hospital laboratories are critical components of healthcare delivery systems. Studies have shown that laboratory data affects approximately 65% of the most critical decisions on admission, discharge, and medication [1]. Laboratory medicine which can also be described as clinical pathology is a field where pathologists provide testing of patient samples (generally blood or urine). For example, the presence of bacteria can be detected from a patient sample, which provides information for the necessary treatment. A clinical test can be conducted on a sample to determine the level of enzymes in the blood to see if a patient has a risk of a heart attack or if the level of glucose in the blood of a patient is related to diabetes. Hospital laboratories are facilities within healthcare delivery systems where laboratory medicine is conducted. There are three stages in the laboratory testing process: Preanalytical, Analytical, and Postanalytical. This research study will only focus on the Preanalytical stage, as this has been identified as the most critical stage from a previous study [2]. The Preanalytical stage process steps include: the physician order, patient identification, dietary and medication considerations, coordination of care and treatment, assessment of physical status (IVs, access ports, etc.), selecting tube types, and the actual blood collection process, which is performed by the phlebotomists. Figure 1 illustrates each step in the Preanalytical process. It has been determined that over 60% of the errors that occur in the hospital laboratory take place in the preanalytical stage [3]. A core cause

for the errors is the work overload experienced by the phlebotomists. When work overload is present, patient neglect has the potential to be introduced due to patients not receiving the time and attention required. Also, with work overload there is a risk for the optimal performance of the phlebotomist to decrease. Phlebotomist performance is critical in laboratory medicine because in the event of an error this could result in serious and even fatal consequences for the patient. By balancing workload, phlebotomists can provide the necessary time and attention needed for each patient. Balanced phlebotomist workload, maximizing resource utilization, patient satisfaction, high service quality, and accurate laboratory performance are vital necessities for healthcare delivery systems as laboratory medicine is a pivotal part of the intricate decision making process, influencing close to 70% of medical diagnosis [4].

Figure 1: Preanalytical Stage in Hospital Laboratory



In this study, a blood draw assignment model has been developed to allocate an optimal number of blood collections to each phlebotomist on each shift. The objective of the blood draw assignment rules are to balance the workload of the phlebotomists within and between shifts, as reducing workload imbalance would result in improved patient care. The proposed model will assist laboratory management in obtaining balanced phlebotomist workload, which could reduce the risk of poor phlebotomist performance and patient neglect caused by work overload. The literature indicates achieving optimal staff scheduling and assignments in healthcare through mathematical modeling has been a viable option for many healthcare managers [5] [6] [7] [8].

However, many of the mathematical models previously developed for staff scheduling and assignments are difficult to utilize due to healthcare managers not having the necessary programming skills required for implementation. The blood draw assignment model presented in this study will allow for uncomplicated implementation as the model has been developed and solved using Microsoft Excel.

The remainder of this paper is outlined as follows. In the subsequent section, the blood draw assignment model and the assumptions made are provided. Following are the results and discussion of the blood draw assignment model. Finally, the conclusions and future research are discussed in detail.

BLOOD DRAW ASSIGNMENT MODEL

A major decision making problem faced in the preanalytical stage of hospital laboratories is how to assign blood collections to the phlebotomists within each hour. The number of blood collections that should be done within each hour block is known with certainty by the phlebotomy manager who is the person responsible for blood collection assignments. Inadequate collection assignments will cause work overload for the phlebotomists and imbalanced workload within the shift. As mentioned previously, work overload can lead to patient neglect as each patient will not receive the time and attention they require. It is also important to ensure that as many blood collections as possible can be conducted during each hour. This will allow the hospital laboratory to see a decrease in the total testing process cycle time. Therefore, the objective is also to minimize the number of blood collections not fulfilled. There is an associated penalty for every blood collection that is not performed. The only resource considered in this problem is the service providers, which are the phlebotomists. To address this problem faced in hospital laboratories, a blood draw assignment model has been developed to determine the optimal number of blood draw assignments for each phlebotomist scheduled during each hour block to balance workload within the shift. The follow assumptions have been made for the model:

- Blood draw collections fall into three categories: tasks that must be done within the hour, tasks that must be done within two hours, and tasks that must be done within three hours. Blood collections that must be completed within one hour are ordered as STAT. This task type implies there is a sense of urgency associated with the patient requiring the blood collection. The tasks that must be done within three hours are the regular blood collection orders. Lastly, the tasks that must be done within two hours are the regular blood collections that rolled over and were not completed within the first hour they were ordered.
- The service time (in minutes), for any phlebotomist at the same level, to perform a regular blood draw and a stat blood draw is the same.
- The phlebotomists are separated into three levels: beginner, average, and experienced.
- The service time for the phlebotomists correspond to the level they are associated with.
- Each phlebotomist has T minutes available to collect blood samples.
- Only one resource (Phlebotomists) is considered.

These insights generated the blood collection assignment rules, which could be easily implemented using any spreadsheet software such as Microsoft Excel.

RESULTS AND DISCUSSION

For laboratory management to balance workload within each hour, blood draw assignments for phlebotomists should be determined using the automated blood draw assignment template. The blood draw assignment template requires the laboratory manager to input the phlebotomists who are scheduled to work during each hour, which is displayed in Figure 2. Next, the demand for the current hour, which is based on task type, should be provided. Blood collection tasks are grouped by no delay, one hour delay, and two hour delay. This information is illustrated in Figure 3. Using these inputs, the blood draw assignment model will allocate blood collections to the phlebotomists based on their skill level. Any blood collections that are left undone will roll over to the following hour and will be categorized under a new task level. For example, if there are 20 type three blood collections left over at 1pm, then these 20 tasks will roll over to 2pm and become type 2 blood collections. This model also keeps track of the tasks that have been assigned to each phlebotomist in previous hours. This is to ensure the number of blood collections allocated does not exceed the specified balanced workload for the phlebotomists. This model should be run hourly, as the blood collection demand changes from hour to hour. The automated blood draw assignment template is provided in Figure 4. This efficient blood draw assignment model could be developed using any spreadsheet software such as Microsoft Excel or Microsoft Access. By implementing the results of the blood draw assignment model, laboratory management should see significant improvements in the hourly workload balance of the phlebotomists scheduled in hospital laboratories.

Figure 2: Phlebotomist Schedule for One Day

| Phlebotomist | k1 | k2 | k3 | k4 | k5 | k6 | k7 | k8 | k9 | k10 | k11 | k12 | k13 | k14 | k15 | k16 | k17 |
|--------------------------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| Service time | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 5 | 5 | 5 | 5 | 5 |
| Maximum Collections/Hour | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 10 | 10 | 10 | 10 | 10 |
| 12am | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1am | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2am | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 3am | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 4am | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 5am | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 6am | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 7am | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| 8am | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 9am | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 10am | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 11am | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 12pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 1pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 2pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 3pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 4pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 5pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 6pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 7pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 8pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9pm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10pm | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11pm | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

shift to balance workload. By implementing the blood draw assignment model in hospital laboratories, healthcare managers should see a substantial increase in laboratory effectiveness and a decrease in laboratory errors.

The limitation of this study is that the blood draw assignment model is utilized for the preanalytical stage only since it was determined to be the most critical stage. However, each stage is an important part of the total testing process. Therefore, all stages should be optimized such that errors are being considerably reduced to achieve the maximum cost savings. Future work will include developing blood draw assignment models for each of the remaining two stages to achieve improved efficiency and effectiveness in the total testing process of hospital laboratories.

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**AN OVERVIEW OF THE CHINESE BANKING SYSTEM
ITS HISTORY,
CHALLENGES AND RISKS**

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ABSTRACT

This paper is an initial review of the history, evolution and current status of the Chinese Banking Industry. Evolving from a single government-controlled institution that acted both as a central and commercial bank, to multiple organizations dominated by market fundamentals and increasing competition, these changes have created several challenges for Chinese financial institutions. The preliminary conclusion is that the role Chinese banks will play in future economic development will be dictated by how well the banks are able to adapt to the new market risk and competition created by market reforms.

ECONOMIC REFORM AND CONDITIONS IN CHINA

Before China's economic reforms three decades ago, the Country was characterized as poor, stagnant, centrally controlled, economically inefficient, and isolated from the rest of the world. Since market reforms were implemented by Deng Xiaoping, in 1979 and its entrance into WTO in 2001, China has become one of the world's fastest-growing economies, with GDP growth averaging around 10% a year over the past three decades (Yan, 2014). In addition it is one of the world's largest merchandise trading economies, second-largest destination of foreign direct investment (FDI), largest manufacturer, and largest holder of foreign exchange reserves (Morrison, 2014).

Although still growing at a pace many envy, China's economy has slowed down in recent years because of the global economic crisis that began in 2008. This has included a decline in exports and imports and the loss of jobs for a significant number of Chinese workers. Because of the slowdown, the Chinese government has introduced a stimulus package hoping to control the economic decline. This has included an injection of four trillion yuan (\$586 billion) into the economy – equivalent to about 16% of China's annual GDP (The Economist, 2008), easing monetary policies to increase bank lending, and various efforts to boost domestic consumption. While these actions are believed to have helped stabilize the economy, the International Monetary Fund is projecting the Chinese GDP will continue to decline through 2015 (WEO, 2014).

While economic growth is slowing, the GDP growth is still the envy of most developed economies and many predict that China will become the world's largest economy in the near future. However, the ability of the country to maintain its growth trajectory for the long run will depend largely on the Chinese government's ability to continue its comprehensive economic reforms and transition to a free market economy. This will include continuing to promote in-country consumer demand for products, encouraging innovation and addressing the significant environmental issues that plague the country. To that end in November 2013, the Communist Party of China held the Third Plenum of its 18th Party Congress, which issued a communique outlining a number of broad policy statements on reforms that would be implemented by 2020. Many of the proposals are measures that would seek to boost competition and economic efficiency (Morrison, 2014). This includes continuing the substantial reforms in the financial and banking sectors.

THE EVOLUTION OF CHINESE BANKING

China's banking system has changed dramatically since 1970s when there was only a single government-controlled banking institution – the Peoples' Bank of China (PBOC). Since that time and with major market reforms, banking is now beginning to be driven by market fundamentals and some foreign competition has begun to take market share.

The Modern Chinese Banking system started its evolution in 1979 with the spin-off of three banks from PBOC (Yan, 2009). This included The Agricultural Bank of China (ABC) which assumed rural banking activities from the PBOC; the Bank of China (BOC) which focuses on foreign currency transactions and international banking business; the People's Construction Bank

of China (PCBC) which is mandate to finance construction and infrastructure projects (Werner and Chung, 2010).

In 1983, the State Council, the chief administrative authority in China, officially designated the PBOC as China's central bank (Turner, Tan and Sadeghian, 2012). The Council also established the PBOC as the main regulator and supervisor of China's early-stage banking system (Werner and Chung, 2010). In order to strengthen its role as the country's central bank, on January, 1, 1984, PBOC transferred its remaining commercial banking functions into a new bank (called the Industrial & Commercial Bank of China (ICBC)), whose mandate was to specialize in urban commercial financing. The Chinese Government also permitted the establishment of a number of other domestic banking institutions from the late 1980s, including the Bank of Communications (BCOM) (Werner and Chung, 2010).

An additional part of the evolution has been to separate policy-related lending from commercial banking in China. This has included the establishment of three policy banks in the mid-1990s - China Development Bank, Import and Export Bank of China, and Agricultural Development Bank of China (Yan, 2009). In addition a law was enacted establishing the four specialized banks (ABC, BOC, CCB and ICBC) as state-owned commercial banks responsible for managing their own operations and risks, in accordance with regulatory compliance guidelines. In addition the Chinese government allowed several joint-stock commercial banks and rural and urban credit cooperatives to be established (Werner and Chung, 2010).

Even with these changes the Chinese government continues to play a major role in the banking business. Along with facilitating and designing regulation for the industry, through the late 1980's and 1990's they influenced and directed lending to many state owned enterprises that were not profitable and relied on borrowed money to fund operations (Lardy, 1999). Along with significant lending into a real estate and stock market boom and the subsequent bust, non-performing loans increased significantly. By the late 1990s the large state-owned banks' aggregate non-performing loan (NPL) ratio exceeded 30 percent (Huang, 2006).

As the banking reforms began to take hold and lending dried up many state-owned enterprises (SOEs) shut down. Since the state-owned commercial banks were the main providers of credit to the SOEs, they were left with serious credit quality issues and non-performing loans grew quickly. Responding to this banking crisis, the Ministry of Finance in 1998 restructured the four state-owned commercial banks and made direct capital contributions of RMB 270 billion or US\$ 33 billion. Four asset management companies (AMCs) were then established in 1999 to purchase, resolve and sell the each bank's non-performing loans (Turner, Tan and Sadeghian, 2012). It should be noted that the repurchase agreement only included loans originated prior to 1996. The government deemed loans made after that date were made of the banks on volition vs. directed by government policy (Peiser and Wang, 2002; Pei and Shirai, 2004). This restructuring has seemed to work with both credit quality and capital adequacy gradually improving.

Despite the recent restructuring process during 1998-99, the banks were still burdened by a substantial level of NPLs which forced a second round of restructurings. These restructurings included both equity infusions as well as NPL carve-outs, resulting in government outlays of hundreds of billions of RMB (Werner and Chung, 2010).

With this restructuring done and the banks successfully recapitalized the Chinese government encouraged State-Owned Commercial Banks to investigate initial public offerings (IPO's) (Werner and Chung, 2010). This was seen as a critical step in the reform process by the government who believed that as publicly traded companies these organizations would be more responsible to non-government shareholders in the form of improved risk and credit management (even though the majority shareholder for the State-Owned Commercial Banks was still the Chinese government). In addition and with a tip of the hat to western banking practices, a number of successful global banks (e.g., Goldman Sachs, American Express, Royal Bank of Scotland, Bank of America) were given unique opportunities to invest in these public offerings prior to public issuance of the stock – a very lucrative transaction. The Chinese government did this in exchange for the investing banks providing assistance and guidance to their new Chinese partner banks on modernize the internal infrastructure of the organizations (Werner and Chung 2010).

Another important change in the Chinese banking market has been the introduction of foreign competition. Over the past two decades, the gradual and cautious opening of the Chinese banking market to foreign banks has involved stages. First stage – because of significant regulatory limitations on operations, foreign banks initially entered the Chinese market from the late 1970s until the early 1990s as service groups for home grown customers. With the gradual relaxation of rules and restriction on foreign national banks, to a large extent driven by China's accession to the WTO, foreign banks have increasingly been entering the Chinese market believing that servicing local businesses and customers could generate significant profits.

The ultimate impact of foreign bank operations on Chinese banks is not yet clear. The Chinese bankers believe that there could be a loss of market share, reduction in profits as competition increases, or talent drain as banks from other countries began to pirate employees. However many argue that as foreign banks gain traction this will force Chinese banks to improve their service quality, efficiency and general competitiveness. Ultimately, this should enhance the likelihood of the long, stable and healthy development of China's banking sector and financial markets (Yan, 2009).

CHALLENGES, DIFFICULTIES AND RISK IN CHINESE BANKS

With the economy slowing, the prospects of a future increase in NPL's and the market slowly being opened to global competition, it is difficult to imagine that more challenging times are not ahead for the Chinese Banking system. Specifically there are two areas of concern and consideration and possibly further investigation.

The biggest risk for Chinese banks is an increase in non-performing loans and the subsequent economic consequences a bank crisis would have on an already slowing Chinese economy. Having bailed out the banks twice because of poor lending decisions there is little appetite for another capital injection and there are signs that this might be needed again. The government has spent more than \$650 billion bailing out banks since the late 1990s. (Bloomberg News, 2014) and it is reported that for the ninth straight quarter NPL's are at the highest level since the 2008 financial crisis. This is no doubt a reflection of the slowdown in the world's second-largest economy and a bad omen for the Chinese economy at large and the banking system.

Furthermore, as the financial services markets expand with the arrival of new competitors and alternative deposit and lending options, customers are becoming harder to keep. In short Chinese banks are finding it difficult to compete in a market where not only foreign competitors are increasingly challenging their turf, but also with new technologies are beginning to encroach on their traditionally stable funding base. For example two Chinese internet giants, Alibaba and Tencent, are moving energetically into financial services. The online financial products and services offered by these two companies have become an immediate hit and are especially popular among the younger Chinese. Moreover, these innovators already have volumes of proprietary data on the online purchasing habits and creditworthiness of consumers giving them a leg-up on the traditional bankers. For example, “Yuebao,” which literally means “leftover treasure” in Chinese, is operated by China’s biggest e-commerce firm Alibaba Group. It is a new financial service that made its debut in China last year, which has succeeded in collecting in excess of RMB 8 trillion (\$1.29 trillion) from 86 million customers as of mid-March and has become a threat to major state-owned commercial banks like the industrial and Commercial Banks of China. The deposits to this company are said to be still growing at more than 5 percent per month.

One Chinese financial expert has said that with the public support for higher returns and the convenience offered through the internet, more than 30 percent of the money deposited by individuals in major banks could be shifted to online money funds within three years. This could give rise to a scenario in which online financing will occupy a major position in China’s financial system (The Japan Times, 2014).

The banking system in China although still controlled by the Chinese government has historically played an important role in the development of China’s economy. However, with bad loans and new competition it is increasingly difficult to determine how affective they will be in promoting development and supporting the investment needed to grow such a large economy. How these institutions adapt to the changing environment will be a good indicator on the effectiveness of Chinese reform efforts and a leading indicator on the prospects for China’s economy.

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AN ANALYSIS OF STUDENT GRADES IN ACCOUNTING I AND II: DOES SEMESTER LENGTH OR GENDER MATTER?

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ABSTRACT

More and more colleges and universities are offering courses in a compressed form in order to accommodate the hectic schedules of their students and faculty. Numerous studies, across disciplines, have looked at the effectiveness of these shortened classes and found mixed results. This study looks at whether the format of an Accounting I class affects student achievement in the Accounting II class. Utilizing data across eight academic years and controlling for numerous variables, including instructor and textbook, results suggest that students in the compressed form of Accounting I performed as well in the Accounting II class as students taking Accounting I in a traditional length class. In addition, this paper attempts to predict whether the grade students received in Accounting I is dependent upon the length of the semester and/or the gender of the student. Results suggest that the length of a semester in which Accounting I was taken and/or the gender of the student is a good predictor of Accounting I grades.

INTRODUCTION

As more individuals attempt to fit college into their busy lifestyles, intensive 3 or 4 week class terms have become more common. Typically, most colleges and universities have offered some variation of an intensive semester for many years by way of summer school. Others include 3 or 4 week intersessions, generally offered either in May or January, as part of their regular academic calendar. Many students often prefer these shortened semesters since they typically take only one course, not four or five as in a traditional-length semester, allowing students to focus on one topic. Instructors often like them because the longer class period allows for more in-depth coverage of the material, resulting, hopefully, in a longer-lasting understanding of the material. However, both students and faculty complain of fatigue, stress and burnout from the intensive nature of these courses. What should be important to everyone is whether intensive courses are an effective approach for student learning. For the most part, studies on the effect of course length on student achievement have shown mixed results. This study investigates whether the length of a class term for an Introduction to Accounting I class makes a difference in student achievement in the Introduction to Accounting II class.

This study also attempts to determine whether a student's grade in Introduction to Accounting I can be predicted based on whether the class was the traditional 13 week semester or the compressed four week class. In addition, gender of students was considered.

LITERATURE REVIEW

Numerous studies have investigated the impact the length of class terms has on student achievement. Most have focused on the differences in identical courses taught in sessions of differing lengths. Van Scyoc and Gleason [3] concentrated on students enrolled in a principles of microeconomics course that was taught in both a 3-week and a 14-week format. They controlled variables such as contact hours, course content, instructor, time-of-day, and cost. The only significant difference between the two subject groups was the length of the term. At the beginning of each class, the Revised Test of Understanding College Economics was administered as a pre-test measure of the students' knowledge

of economic concepts. The same test was given to the students at the end of the course. They found that students in the 3-week course scored significantly better on the post-test than students taking the 14-week course. In addition, to measure differences in long-term retention of the microeconomic concepts between the two groups, they administered the same test to students on the first day of a subsequent intermediate microeconomics course. On average, four semesters had elapsed since the principles course had been taken by the students. They found no significant differences between the two groups.

Anastasi [1] also investigated the effectiveness of class length and found that overall academic performance, measured by course grade, was similar in full-semester courses and intensive courses. They examined student performance in three different psychology courses taught over both a 16-week semester and a shortened summer session. After controlling for instructor, teaching style, contact hours, examinations and other assignments, they found no significant difference in the final course grades between the two groups.

Most research has focused on short-term performance by students. However, Seamon [2] measured both short-term and long-term performance differences. Students in an educational psychology class taught in both an intensive and traditional-length format were given a pre- and post-test at the beginning and the end of the course. The test consisted of 25 multiple-choice questions designed to measure understanding of specific learning objectives for the course. In addition, approximately half of the questions measured declarative knowledge while the other half included higher order learning-type questions. They found that students in the intensive courses performed better on the post-test, especially on the higher order questions, than did students in the semester-length class. In addition, they conducted a follow-up study three years later, administering the same post-test to 29% (9) of the original thirty-one participants. They found no significant differences between the two groups, suggesting that, in the long run, semester length is not significant to learning.

RESEARCH QUESTIONS AND METHODOLOGY

This study investigates several questions. First it looks at whether the length of the class term for the first introductory accounting class makes a difference in student performance in the second introductory accounting class. Second, this study attempts to determine whether or not the length of an academic term can be used to predict the grade a student will earn in Accounting I. Finally, a model was designed to determine if both gender and the length of semester could be used to predict the final grade in Accounting I.

The subjects for this study were students at a small, liberal arts college in the mid-Atlantic region whose academic year consists of fall, January, and spring terms. Fall and spring are traditional-length courses lasting 13 weeks each while the January term is a 4-week mini-session where students typically meet five days a week for two hours each day. Most students take only one course but are permitted to enroll in two. Traditionally, Introduction to Accounting I—the first accounting course required of majors—is offered in both fall and January while Introduction to Accounting II is offered only in the spring. Accounting I is a pre-requisite for Accounting II and consists entirely of financial accounting concepts. Approximately 75% of Accounting II covers financial accounting while the remaining 25% covers managerial topics. The same instructor teaches all of the Accounting I courses during the fall and January terms, in addition to one section of Accounting II in the spring. Approximately, 75 students take Accounting I each year with the number dropping slightly for Accounting II.

The study utilizes data from eight academic years, 2005 – 2006 to 2012 – 2013, and includes students that took Accounting I in either fall or January and then took Accounting II in the immediately following spring term. All of the courses included in the study were taught by the same professor, minimizing any potential noise in the analysis. In addition, the same book, albeit different editions, was used throughout all of the courses. This resulted in a total of 198 subjects, 132 (69.2%) that took Accounting I in the fall and 61(30.8%) in January. In addition, 116 (58.6%) of the subjects were male while 82 (41.4%) were female. Table 1 provides a breakdown of the group.

TABLE 1: TEST SUBJECT BREAKDOWN

| | | Academic Year | | | | | | | |
|-------------------|-------|---------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|
| Accounting I term | Total | 2005 – 2006 | 2006 – 2007 | 2007 – 2008 | 2008 – 2009 | 2009 – 2010 | 2010 – 2011 | 2011 – 2012 | 2012 -- 2013 |
| Fall | 137 | 18 | 19 | 20 | 16 | 19 | 14 | 16 | 15 |
| January | 61 | 2 | 5 | 8 | 8 | 8 | 11 | 9 | 10 |
| Total | 198 | 20 | 24 | 28 | 24 | 27 | 25 | 25 | 25 |
| Gender | | | | | | | | | |
| Male | 116 | 8 | 17 | 14 | 10 | 20 | 14 | 15 | 18 |
| Female | 82 | 12 | 7 | 14 | 14 | 7 | 11 | 10 | 7 |
| | 198 | 20 | 24 | 28 | 24 | 27 | 25 | 25 | 25 |

The first question to be investigated is whether or not the length of the term for Accounting I affects the final grade received in Accounting II. T-tests were utilized to determine whether differences between the two terms exist. In addition, final course grades for male versus female students were analyzed to determine if gender had an impact on course performance.

The second question asks if the length of the term could be used to predict the final grade in Accounting I. Similarly, the third question attempts to determine whether both gender and length of term affects the final course grade in Accounting I. Chi-square tests will be used to evaluate the second and third question.

RESULTS

Question 1:

To determine if the length of the class term for Accounting I makes a difference in course performance for Accounting II, t-statistics were run comparing final course grades in Accounting II for the traditional-length students to those in the intensive course group. As Table 2 shows, no significant difference exists between the two groups. T-statistics assuming unequal variances were calculated also and showed no significant differences ($t = -.12$) between the two groups. In addition, no significant differences between final course grades for males versus females were found.

Question 2:

For both of the remaining questions, observed grades were categorized as A (90% to 100%), B (80% to 89.9%) and C/D/F (0% to 79.9%). Only three categories were utilized in order to avoid any expected results of less than 5. If expected results are less than 5, an overestimated chi-square could result.

Expected results were then determined in order to evaluate the ability to predict whether the length of term can be used to predict the final grade in Accounting I. Table 3 provides a summary of the observed and expected results for the first question. The obtained chi-square was 6.69 with degrees of freedom equal to 2 and was significant at the .10 level, resulting in a rejected null hypothesis that a significant difference does not exist between the observed and the expected results. Consequently, one can surmise that the length of the semester is a predictor of a student's grade in Accounting I. The impact of the length of the term in which Accounting I was taken was used to predict grades for Accounting II also, however, no significant results were obtained.

TABLE 2: T-TEST: TWO-SAMPLE ASSUMING EQUAL VARIANCES

| Semester Length | | |
|------------------------------|--------------------|------------------|
| | <i>Traditional</i> | <i>Intensive</i> |
| Mean | 0.814649809 | 0.816289041 |
| Variance | 0.009695972 | 0.005721504 |
| Observations | 137 | 61 |
| Pooled Variance | 0.008479298 | |
| Hypothesized Mean Difference | 0 | |
| df | 196 | |
| | - | |
| t Stat | 0.115651962 | |
| P(T<=t) one-tail | 0.454023391 | |
| t Critical one-tail | 1.652665059 | |
| P(T<=t) two-tail | 0.908046782 | |
| t Critical two-tail | 1.972141222 | |

Table 3: Observed and Expected Frequencies of Accounting I Grades

| | A | B | C/D/F | Totals |
|-------------------------|----------------------|----------|--------------|---------------|
| Traditional Length Term | 38 (38) ¹ | 49 (56) | 50 (43) | 137 |
| Intensive Length Term | 17 (17) | 32 (25) | 12 (19) | 61 |
| Totals | 55 | 81 | 62 | 198 |

¹ Number in parentheses are expected values

Chi-square = 6.6904; *df* = 2; *p* < .05

Question 3:

The third question further classifies the population, predicting the final grade in Accounting I using both the length of the term and the gender of the student. Students were classified into one of four categories: traditional term and female, traditional term and male, intensive term and female and intensive term and male. The obtained chi-square was 15.44 with degrees of freedom equal to 6 and was significant at the .10 level, resulting in a rejected null hypothesis that a significant difference does not exist between the observed and the expected results. Consequently, one can surmise that the length of the semester combined with the gender of the student is a predictor of a student's grade in Accounting I. The impact of both of these variables to predict grades for Accounting II was analyzed

also, however, no significant results were obtained. Table 4 provides a summary of the observed and expected results.

Table 4: Observed and Expected Frequencies of Accounting I Grades

| | A | B | C/D/F | Totals |
|-----------------------------|----------------------|---------|---------|--------|
| Traditional Term and Female | 22 (15) ¹ | 20 (23) | 14 (18) | 56 |
| Traditional Term and Male | 16 (23) | 29 (33) | 36 (25) | 81 |
| Intensive Term and Female | 8 (7) | 13 (11) | 5 (8) | 26 |
| Intensive Term and Male | 9 (10) | 19 (14) | 7 (11) | 35 |
| Totals | 55 | 81 | 62 | 198 |

¹ Number in parentheses are expected values
 Chi-square = 15.4428; *df* = 6; *p* < .10

DISCUSSION

As the statistics show, the students taking Accounting I in the intensive 4-week format performed just as well in Accounting II as those taking the initial course in the traditional 13-week semester. Controlling for instructor and course materials, class length does not appear to be a significant factor in how well a student retains and utilizes material from a pre-requisite course.

Interestingly, even though no significant differences existed between the final course grade in both groups, the variances in the grades within the groups did differ significantly. Students from the traditional-length group had much more dispersion in their Accounting II grades than did the students in the intensive-format group. As Table 5 shows, an F-test on the variances shows significance at the *p* > .01 level. Self-selection bias may be one explanation for this finding. Knowing the intense nature of a 4-week course, better students may self-select into it while weaker students may choose the traditional-length class. In addition, the time between the two classes may have had an impact on student performance. Students in the 4-week intensive course started Accounting II one week following the completion of Accounting I. The traditional-length group did not begin Accounting II until approximately two months after finishing Accounting I.

TABLE 5: F-TEST TWO-SAMPLE FOR VARIANCES

| Average Course Graded for Accounting II | | |
|---|--------------------|------------------|
| | <i>Traditional</i> | <i>Intensive</i> |
| Mean | 0.814649809 | 0.816289041 |
| Variance | 0.009695972 | 0.005721504 |
| Observations | 137 | 61 |
| df | 136 | 60 |
| F | 1.694654379 | |
| P(F<=f) one-tail | 0.011233517 | |
| F Critical one-tail | 1.45876588 | |

In addition, the independent variables of length of term and gender appear to be good predictors of a student's grade in the first accounting course for undergraduate students.

Future research should be conducted to provide further evidence as to the importance of class length and gender on student learning. Using the same initial data from this research, it might be interesting to identify which students continued on into Intermediate Accounting and analyze whether the length of the Accounting I class makes a difference in their performance in Intermediate.

CONCLUSION

Previous research on whether the length of a course term affects student performance primarily focused on single courses and showed mixed results. No definitive conclusions were reached. In addition, a few studies attempted to measure long-term effects of class length on retention of course material, again, with mixed results. Like the previous studies, the current research found no significant differences in student performance either. For institutions utilizing the intensive format approach, this is good news. Instructors and students can be reasonably assured that the material learned in the first course of a pair of sequential courses will be retained just as well no matter what term length a college or university utilizes.

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COMPARING TWO DELIVERY METHODS TO TEACH MICROCOMPUTER APPLICATIONS

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ABSTRACT

There are three standard names for distance education. They are Web-Facilitated, Hybrid, and online education. Other names exist as well, such as blended education and web-assisted education. The purpose of this study is to determine if there is a difference between the traditional delivery method of teaching and the web-assisted (hybrid) delivery method of teaching the microcomputer applications course. In the study, the students learned the four major tools of Microsoft Office. During this study, all of the students took four productivity exams in the classroom and there were differences beyond that. In the end, the major difference was with the Microsoft Access exam.

LITERATURE REVIEW

Online education is titled differently between institutions. But all online education started as distance education. Within distance education are many terms. Distance education was formerly popular and used for correspondence courses. Now with the Internet the term distance education has nearly gone by the wayside. Today Allen & Seaman, as cited in [2] define education in four levels based on the percent of time spent online. "Traditional education involves face-to-face interaction only. Web-facilitated education includes web-based content that supplements face-to-face education with only

1 to 29 percent of the content delivered online. Blended or hybrid education combines online and traditional face-to-face education, with 30 to 79 percent of the content delivered in an online format. Online education delivers 80 percent or more of the content in an online format." (p. 97) Martyn [1] prefers the term Blended as to hybrid and believes there needs to be a balance between asynchronous and synchronous interaction. In planning online education, whatever the level of online the assessments should be the same as traditional face-to-face courses. If a department, college or university has not entered the online arena, then the blended education model may just be the way to start as it gives the instructor much of the classroom management that they are used to in the traditional method.

PURPOSE

The authors of this study asked the question, "Is there a difference between the traditional delivery method of teaching and the web-assisted (hybrid) delivery method of teaching the microcomputer applications course?" Data were collected in the spring of 2012 and 2013. Each author had two sections per semester. This would approximate 100 students per author.

ABOUT THE COURSE

Microcomputer Applications is a freshman level course whose main objectives are to learn how to use Microsoft Office to organize ideas and information, solve business problems, and manage data. The students learn the tools in Microsoft Office - Word, Access, Excel, and PowerPoint. It was assumed the students had a basic knowledge of computing and the Windows and Internet were not directly taught. Windows is indirectly taught through the downloading of data files and during the semester as students need help with concepts such as locating and saving to their USB in the environment. The textbook used was *Microsoft Office 2013 Introductory Concepts and Techniques, Windows 7 & 8 Edition* Shelly, Cashman, Vermaat. Course Technology. The advantage of this textbook is that it is written with step-by-step directions followed by screen captures of the process. This works equally well in both delivery methods. Four exams were administered during the course, one for each of the tools. These were productivity based and were written by one of the authors.

Traditional Delivery Method

The Traditional Delivery Method is face-to-face in a computer lab. Step-by-step instructions were written and the students were led through downloading data files as many of them had never unzipped a folder nor worked with data files. The instructor who taught the Traditional Delivery Method used the “facilitator” approach or sometimes referred to as “the manager of the learning environment.” Very little time was devoted to “lecturing” or demonstrating the tools. Only at the beginning of a tool when specifics were necessary to the assignments did the instructor demonstrate. For example, walking the students through how to “show formulas” in Excel, or create a simple database in Access. The rest of the time, the instructor would help students independently solve his

or her problems or answer their questions. This gave more time to get to know the students and they were able to work independently. As for assignments, all of them were given at the beginning of each tool for that tool. The due date for all assignments was the day of the exam for that tool. The students all had a folder and as they printed their assignments, they filed them in a file cabinet. Attendance was required for the class.

Web-Assisted Delivery Method

The Web-Assisted Delivery Method in this study was an online delivery method whereby the students met face-to-face for an introduction to the class then met in person for exams that were given in the computer lab. During the first class period the instructor met with the students and welcomed them to THEIR class. The syllabus was distributed and course requirements were discussed. A class email address was given to the students as well as the instructor’s personal cell phone. In addition, the instructor was available in his office on short notice for students who wanted to meet. It was made clear that between email, office visits and cell phone the instructor was available 24/7. The students were required to develop four portfolios as their means of assignments in learning the material. On the first day of class developing portfolios were explained. Because it was THEIR class, the students chose the due dates for each of the portfolios. Exams were administered on the portfolio due date and specified time period. An explanation of downloading data files was given.

Advantages of the Web-Assisted Delivery Method

- It is student centered – there is much more emphasis on the learner.
- The student is in charge of their own learning.

- It is up to the student to get the information they need.
- The student's quest for knowledge is not limited to their textbook or what the instructor shows [email] or discusses in class [cell phone]. The student has a world of additional resources available on the Internet, and classmates to work collaboratively with.
- The student can work on the course when and where it's convenient to them.

Disadvantages of the Web-Assisted Delivery Method

- A web-assisted course will feel uncomfortable at first – it may be a totally new experience.
- The student may not be comfortable being responsible for his/her learning. Students in a web-assisted course often feel some dissonance, discomfort and frustration. The learning curve for the first course can be a little steep.
- Web-assisted instruction is not a good learning style for some and for those web-assisted instruction should be avoided.

METHODS/RESULTS

Four exams were identical for both teaching methods and were administered throughout the course (one for each tool). They were productivity in nature. One author graded the exams for all sections (both delivery methods) to remove any grading bias given the nature of the exams.

As of now the results are measured in Means and Medians. The statistical analysis will be presented at the conference. As well the attrition rate will be calculated.

TABLE 1

| Exam Values | |
|---------------|----------------|
| Word | 35 pts. |
| Access | 60 pts. |
| Excel | 40 pts. |
| PPT | 35 pts. |

TABLE 2

| Microsoft Word | | |
|----------------|--------------------|--------------------|
| Year | Traditional | Web-Assisted |
| 2012 | Mean – 33 | Mean – 32 |
| | Median - 34 | Median – 33 |
| 2013 | Mean – 33 | Mean – 32 |
| | Median – 35 | Median – 34 |

TABLE 3

| Microsoft Access | | |
|------------------|--------------------|--------------------|
| Year | Traditional | Web-Assisted |
| 2012 | Mean – 50 | Mean – 41 |
| | Median – 53 | Median – 43 |
| 2013 | Mean – 50 | Mean – 43 |
| | Median – 51 | Median – 48 |

TABLE 4

| Microsoft Excel | | |
|-----------------|--------------------|--------------------|
| Year | Traditional | Web-Assisted |
| 2012 | Mean – 35 | Mean – 32 |
| | Median – 35 | Median – 34 |
| 2013 | Mean – 35 | Mean – 33 |
| | Median – 36 | Median – 36 |

TABLE 5

| Microsoft PowerPoint | | |
|----------------------|--------------------|--------------------|
| Year | Traditional | Web-Assisted |
| 2012 | Mean – 34 | Mean – 33 |
| | Median – 34 | Median – 34 |
| 2013 | Mean – 34 | Mean – 33 |
| | Median – 34 | Median – 34 |

CONCLUSIONS

There are four primary distinctions of online education. The online method in this study was the hybrid or blended method, named in this particular University web-assisted. Four productivity exams were administered to both the traditional group and the web-assisted group of a course, Microcomputer Applications. Advantages and disadvantages to web-assisted learning were given.

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MODELING DISASTER UNCERTAINTY WITH FUZZY GOAL PROGRAMMING

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ABSTRACT

The uncertainty in the timing and severity of disaster events makes the long-term planning of mitigative and recovery actions not only very difficult but also very critical. Often planners use expected values for hazard occurrences, leaving communities vulnerable to worse-than-usual and even so-called “black swan” events.

This research models disasters in terms of their best-case, most-likely, and worst-case estimates. These values are then embedded in a fuzzy goal programming model to provide community planners and stakeholders with the ability to strategize for any range of events from best-case to worst case, as their community wishes to plan. Examples are given illustrating the modeling approach.

INTRODUCTION

Disasters have been occurring with greater frequency and with greater impact over the last fifty years than previously; in fact the rise in losses is increasing almost exponentially over this period [3]. It is therefore important to bring the expertise of the disaster operations management field to bear on these events.

Disaster operations managers however have not laid out a definitive solution approach as to how to deal with uncertainty in disaster planning. Most planning is expected-value in nature, whereby mitigation against future events is usually targeted against the expected disaster. However, recent disasters such as Hurricane Sandy in the United States and Typhoon Haiyan in the Philippines demonstrate that planning for expected-value disasters, but getting much worse, can result in terrible tragedy and loss of life.

This paper examines one way in which disaster uncertainty may be modeled that goes beyond expected-value planning. With this approach, planners may choose to attack the worst-case likelihood; the best-case; or the most-likely scenarios as they wish. Output of the model presented here is a list of which projects from those available will best meet the chosen likelihood goal.

LITERATURE REVIEW

The literature notes that the progress in sustainable planning for multi-hazards within a long-term framework that considers both mitigation against future disasters and recovery from past disasters is solid but limited. In particular, there is only one piece of analytical work that considers both mitigation and recovery over a long-term horizon, and that is an unpublished dissertation by

Chacko [2]. Other strong work exists that covers just mitigation, or just recovery (see, e.g., [4] and [7]); but such work has not studied both together.

Chacko points out in his dissertation that the next step in disaster planning beyond his combined mitigation and recovery long-term analysis is the establishment of similar work that deals explicitly with uncertainty in inter-arrival time and severity forecasts. But he does not solve that problem.

Hannan [6], based on goal programming work by Charnes and Cooper [5] and fuzzy set theory by Bellman and Zadeh [1], has developed a fuzzy goal programming model for fuzzy multiple goals. Yet Hannan neither applies his approach to the disaster management context nor shows how one can apply resource allocation models to bring a widely varying distribution of likely severity values under better control (e.g., less variation at the high end of the damage distribution).

This research shows how a disaster operations manager can modify in a controlled manner a hazard's severity posture by intelligently allocating resources. That is, this paper shows how a planner can reshape a severity distribution toward another target shape by selecting a proper set of mitigative projects from a portfolio.

MODEL

For the sake of simplicity, consider a single type of hazard known to strike a community on a repetitive, but irregular (i.e., not completely predictable) basis. Using historical data, or expert opinion if sufficient data are not available, determine (1) the most likely level of disaster damage to occur; (2) assess the most-favorable (best-case) likely damage amount; and finally estimate the worst-case scenario that is possible. Then call these three values representing the uncertainty inherent in a hazard at a current point in time the *status quo* severity of the hazard.

Furthermore, assume the community has defined a set of *target* severity values for hazards likely to impact it. Obviously, the community cannot change the hazard itself; rather it must define a set of projects that it wants to complete in order to mitigate against future disasters, thereby reducing the hazard's effect down toward the target values.

Now model the uncertainty in these hazards by representing the damage severity – both the projected severity given the *status quo*, and the *target* (desired) severity – by using fuzzy sets [1]. As such, define the following notation; see Figures 1 and 2:

- a** = the *best-case* strength of belief of the status quo's disaster damage
- b** = the *worst-case* strength of belief of the status quo's disaster damage
- m** = the *most-likely-case* strength of belief of the status quo's disaster damage
- a_T** = the *best-case* strength of belief of the target's disaster damage
- b_T** = the *worst-case* strength of belief of the target's disaster damage
- m_T** = the *most-likely-case* strength of belief of the target's disaster damage.

Now let the term “deviation” represent the distance from the target that a given community finds itself with respect to its surmised level of likely disaster damage.

FIGURE 1.
Strength of belief that the likely level of disaster damage
*will be the specified *status quo* value*

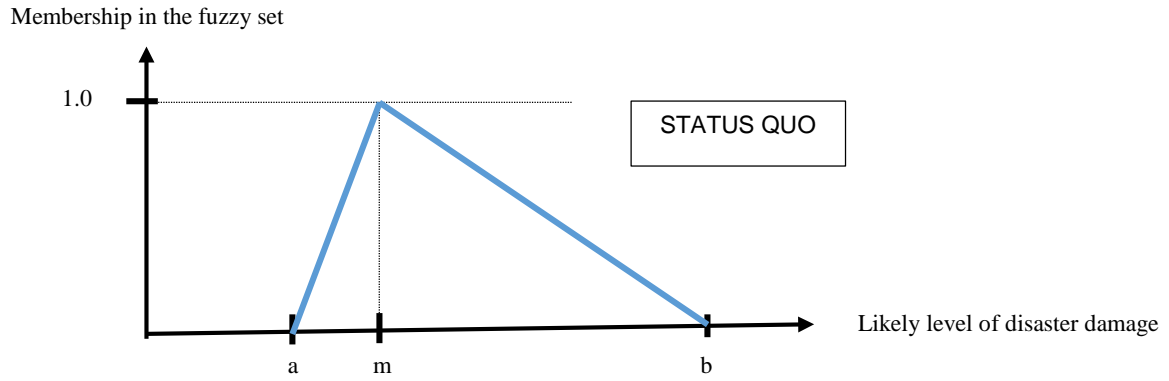
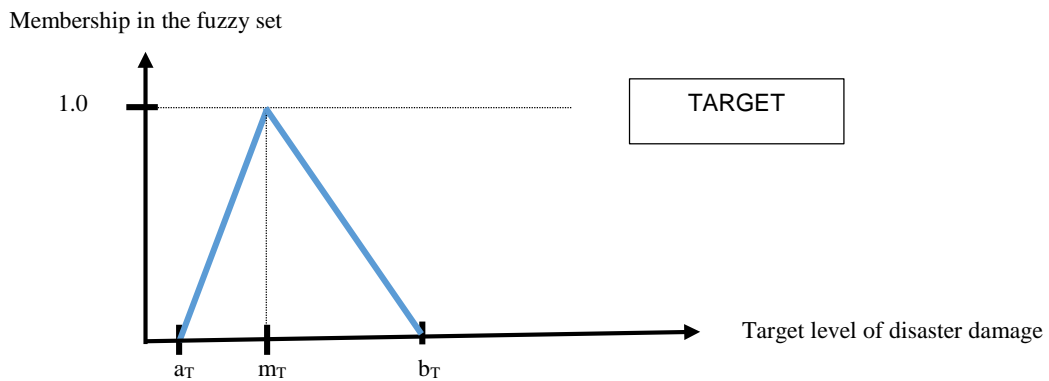


FIGURE 2.
Strength of belief that the likely level of disaster damage
*should be at the specified *target* value*



Next define the following variables:

\mathbf{d}_a = deviation of the “best-case” strength of belief in likely disaster damage
 = “modified status quo best case” – target best case
 = $\mathbf{a} - \mathbf{a}_T$

\mathbf{d}_b = deviation of the “worst-case” strength of belief = $\mathbf{b} - \mathbf{b}_T$

\mathbf{d}_m = deviation of the “most-likely-case” strength of belief = $\mathbf{m} - \mathbf{m}_T$.

w_a = relative weight/importance given by the community to the *best-case* deviation \mathbf{d}_a

w_b = relative weight/importance given by the community to the *worst-case* deviation \mathbf{d}_b

w_m = relative weight/importance given by the community to the *most-likely-case* deviation \mathbf{d}_m .

These three weights are defined such that $\sum_l w_l = 1$.

This allows us to define an objective function \mathbf{Z} that we can minimize as follows:

$$\text{Min } \mathbf{Z} = w_a \mathbf{d}_a + w_m \mathbf{d}_m + w_b \mathbf{d}_b.$$

Now assume there are N possible mitigation and recovery projects X_i , $i = 1, 2, \dots, N$.

Further define each project as binary ($X_i = \{0, 1\}$), although a project could also be defined as a continuous variable on the range $[0, 1]$. For the binary case, $X_i = 1$ means project i is undertaken; $X_i = 0$ represents a mitigation or recovery project that is not undertaken.

If budget and/or policy and/or geographic, etc., constraints are assumed, then an integer mathematical programming problem may be formulated:

$$\text{Min } \mathbf{Z} = w_a \mathbf{d}_a + w_m \mathbf{d}_m + w_b \mathbf{d}_b \tag{1}$$

$$\text{s.t./ } \mathbf{F}\mathbf{x} \leq \mathbf{R} \tag{2}$$

$$\mathbf{x} = \{0, 1\}.$$

Define \mathbf{X}^a as the subset of projects intended to reduce the lower limit \mathbf{a} toward \mathbf{a}_T ; and

\mathbf{X}^m as the subset of projects intended to reduce the lower limit \mathbf{m} toward \mathbf{m}_T ; and

\mathbf{X}^b as the subset of projects intended to reduce the lower limit \mathbf{b} toward \mathbf{b}_T .

Further define α_i^a as the reduction factor percentage if project $x_i \in \mathbf{X}^a$ is undertaken;

α_i^m as the reduction factor percentage if project $x_i \in \mathbf{X}^m$ is undertaken; and

α_i^b as the reduction factor percentage if project $x_i \in \mathbf{X}^b$ is undertaken;

Then

$$\mathbf{d}_a = (1 - \sum_i \alpha_i^a x_i) \mathbf{a} - \mathbf{a}_T; \tag{3a}$$

$$\mathbf{d}_m = (1 - \sum_i \alpha_i^m x_i) \mathbf{m} - \mathbf{m}_T; \tag{3b}$$

$$\mathbf{d}_b = (1 - \sum_i \alpha_i^b x_i) \mathbf{b} - \mathbf{b}_T. \tag{3c}$$

EXAMPLES

Assume there is a community that faces an ongoing threat from a flooding hazard. The community has done some projects in the past to mitigate against the severity of future events, but unfortunately much remains to be done.

Should a flood typical of the past few years inundate the community, disaster severity estimates are as follows: the best-case event would lead to a town loss of \$1M; the most-likely flood would cause a loss of \$2M; and the worst-case disaster would result in flood waters that actually reached downtown, causing damage of \$8M. If the abscissa of Figure 1 is scaled to \$M, then the triangular values there for this case would be $\mathbf{a} = 1$; $\mathbf{m} = 2$; and $\mathbf{b} = 8$. Town leaders have proclaimed that they would like to mitigate floods so that they achieve the target triangle of Figure 2 (again scaled in \$M) with $\mathbf{a}_T = 0.5$; $\mathbf{m}_T = 1.5$; and $\mathbf{b}_T = 3$.

To achieve the target triangle, town stakeholders have proposed 4 different projects; benefits gained from each project, as well as costs to complete each project, are detailed in Table 1. It should be noted that if projects 3 and 4 are undertaken simultaneously, there will be a cost savings of \$0.2M (due to sharing of equipment, reduced setup time, etc.) that will accrue because the same construction firm will do both projects. Resources that are available or that can be obtained are \$2.3M.

TABLE 1.
Community Mitigation Projects under Consideration

| Project | Mitigation Benefits (\$M) | | | Cost (\$M) |
|---------|---------------------------|-----|-----|------------------|
| | a | m | b | |
| 1 | 0.3 | 0.5 | 2.1 | 1.2 |
| 2 | 0.1 | 0.0 | 1.3 | 0.8 |
| 3 | 0 | 0.2 | 1.5 | 0.9 [†] |
| 4 | 0.2 | 0.3 | 1.2 | 0.8 [†] |

[†] Note: Undertaking Projects 3 and 4 simultaneously saves the community \$0.2M.

Community Budget = R = \$2.3M.

Example 1: Black-Swan Analysis

We first consider an example where the community and stakeholders decide that if the worst-case value of $\mathbf{b} = \$8\text{M}$ occurs in an extreme disaster, the community may very well never be able to recover because it includes the downtown business district. Although it is appreciated that this is a highly unlikely event, we assume the community decides it must mitigate the worst-case scenario down from a value of \mathbf{b} to the target value $\mathbf{b}_T = \$3\text{M}$.

Solution:

Reducing the value of \mathbf{b} while leaving \mathbf{a} and \mathbf{m} unchanged is a community effort that attacks only the black swan possibility while leaving more “common” flood mitigation at its current levels.

We start with equation (1), putting all the weight on \mathbf{b} . This is done by setting

$$w_a = w_m = 0; w_b = 1. \text{ This gives}$$

$$\begin{aligned} \text{Min } \mathbf{Z} &= w_a \mathbf{d}_a + w_m \mathbf{d}_m + w_b \mathbf{d}_b = w_b \mathbf{d}_b, \text{ or} \\ \text{Min } \mathbf{d}_b. \end{aligned} \quad (1')$$

But from (3c) and the fact that $\mathbf{b} = 8$ and $\mathbf{b}_T = 3$,

$$\begin{aligned} \mathbf{d}_b &= (1 - \sum_i \alpha_i^b x_i) \mathbf{b} - \mathbf{b}_T = \{1 - [((2.1)/8)x_1 + ((1.3)/8)x_2 + ((1.5)/8)x_3 + ((1.2)/8)x_4]\} \mathbf{8} - \mathbf{3} \\ &= 8 [1 - (0.2625x_1 + 0.1625x_2 + 0.1875x_3 + 0.15x_4)] - 3. \end{aligned} \quad (3c')$$

The problem then becomes

$$\text{Min } 8 [1 - (0.2625x_1 + 0.1625x_2 + 0.1875x_3 + 0.15x_4)] - 3$$

st/

Budget

$$x_1, x_2, x_3, x_4 \in \{0, 1\}.$$

But we can write the budget, with its cost reduction if projects 3 and 4 are undertaken together, in the following manner:

Define x_5 to be a new (hypothetical) project that consists in doing projects 3 and 4 together; then we can write the budget as the following two constraints taken together:

$$1.2x_1 + 0.8x_2 + 0.9x_3 + 0.8x_4 - 0.2x_5 \leq 2.3$$

$$2x_5 \leq x_3 + x_4 \leq x_5 + 1.$$

The solution is $x_1=0$; $x_2 = x_3 = x_4 = 1$. *Cost* = \$2.3M; *Benefit* = \$4.0M. Hence, \mathbf{b} is reduced to $\mathbf{b} = 8 - 4 = 4$, which is still \$1M higher than the target. This concurs with equation (3c'), which says

$$\mathbf{d}_b = 8 [1 - (0.2625x_1 + 0.1625x_2 + 0.1875x_3 + 0.15x_4)] - 3 = 8(0.5) - 3 = 1.$$

Example 2: Reduce Most Common Severities

Assume the community and stakeholders now decide to ignore the worst-case scenario and to focus instead on the more likely eventualities. In particular, assume the town decides to use its 4 projects to attempt to meet the target values for \mathbf{a} and for \mathbf{m} equally, and that it wants $\mathbf{a}_T = 0.5$ and $\mathbf{m}_T = 1.5$.

Then we have:

$w_a = w_m = 0.5$; $w_b = 0$. This gives

$$\text{Min } \mathbf{Z} = w_a \mathbf{d}_a + w_m \mathbf{d}_m + w_b \mathbf{d}_b = 0.5 (\mathbf{d}_a + \mathbf{d}_m).$$

But from equations (3a) and (3b) and the fact that $\mathbf{a} = 1$ and $\mathbf{a}_T = 0.5$; $\mathbf{m} = 2$ and $\mathbf{m}_T = 1.5$,

$$\begin{aligned} \mathbf{d}_a &= (1 - \sum_i \alpha_i^a x_i) \mathbf{a} - \mathbf{a}_T = \{1 - [((0.3)/1)x_1 + ((0.1)/1)x_2 + ((0)/1)x_3 + ((0.2)/1)x_4]\} \mathbf{1} - 0.5 \\ &= [1 - (0.3x_1 + 0.1x_2 + 0.2x_4)] - 0.5. \end{aligned} \quad (3a'')$$

This part (\mathbf{d}_a) of the problem then becomes

$$\text{Min } [1 - (0.3x_1 + 0.1x_2 + 0.2x_4)] - 0.5 = \text{Min } [0.5 - (0.3x_1 + 0.1x_2 + 0.2x_4)]$$

st/

$$1.2x_1 + 0.8x_2 + 0.9x_3 + 0.8x_4 - 0.2x_5 \leq 2.3$$

$$2x_5 \leq x_3 + x_4 \leq x_5 + 1.$$

$$x_1, x_2, x_3, x_4 \in \{0, 1\}.$$

Similarly,

$$\begin{aligned} \mathbf{d}_m &= (1 - \sum_i \alpha_i^m x_i) \mathbf{m} - \mathbf{m}_T = \{1 - [((0.5)/2)x_1 + ((0)/2)x_2 + ((0.2)/2)x_3 + ((0.3)/2)x_4]\} \mathbf{2} - \mathbf{1.5} \\ &= 2 [1 - (0.25x_1 + 0.10x_3 + 0.15x_4)] - 1.5 = 0.5 - (0.5x_1 + 0.2x_3 + 0.3x_4). \end{aligned} \quad (3b'')$$

The minimization problem for Example 2 becomes $\text{Min } 0.5[\mathbf{d}_a + \mathbf{d}_m]$, or

$$\text{Min } 0.5\{[0.5 - (0.3x_1 + 0.1x_2 + 0.2x_4)] + [0.5 - (0.5x_1 + 0.2x_3 + 0.3x_4)] - 2\}, \text{ or}$$

$$\text{Min } 0.5[1 - (0.8x_1 + 0.1x_2 + 0.2x_3 + 0.5x_4)]$$

st/

$$1.2x_1 + 0.8x_2 + 0.9x_3 + 0.8x_4 - 0.2x_5 \leq 2.3$$

$$2x_5 \leq x_3 + x_4 \leq x_5 + 1.$$

$$x_1, x_2, x_3, x_4 \in \{0, 1\}.$$

Solution:

The solution is $X_2 = X_3 = 0$; $X_1 = X_4 = 1$. *Cost* = \$2.0M; *Benefit* = \$0.5M for *a* and \$0.8M for *m*. Hence, *a* is reduced to

$\mathbf{a} = 1 - 0.5 = 0.5$, which achieves the target. This concurs with equation (3a''), which says

$$\mathbf{d}_a = [1 - (0.3x_1 + 0.1x_2 + 0.2x_4)] - 0.5 = [1 - (0.5)] - 0.5 = 0.$$

Similarly, *m* is reduced to

$\mathbf{m} = 2 - 0.8 = 1.2$, which is \$0.3M *below* the target (\$1.5M), i.e., the target is achieved *plus* another \$0.3M. This concurs with equation (3b''), which says

$$\mathbf{d}_m = 0.5 - (0.5x_1 + 0.2x_3 + 0.3x_4) = 0.5 - (0.8) = -0.3.$$

Note two things. First with respect to Example 2, the optimal solution was a \$2M cost to attain a \$1.3M benefit. Note that this is not unreasonable *because* a benefit of \$1.3M will be obtained *every time* there is a flooding disaster. So the second such flood will lead to savings beyond the investment in the mitigation projects.

Secondly, note that planning for black swan events is risky politically even though it may be necessary to “save the town.” If a community expends \$2.3M for a projected benefit of \$4.0M, that “looks very good on paper.” However, if the \$2.3M is spent and then (say) five floods occur *none of which* is a black swan, the townsfolk are likely to become disillusioned at such a costly expenditure that has done absolutely nothing for the town over the last five disasters. At least the model developed in this paper enables stakeholders to plan in a manner that is consistent with their wishes. And this model does allow compromise solutions, such as weighting a black swan with (say) half the funds and the more likely eventualities with the other half.

CONCLUSIONS AND FUTURE WORK

The research has developed and demonstrated a procedure for the determination of resource allocation for communities that wish to protect against the uncertainty of a black swan event, or mitigate against more likely events. The procedure utilized a fuzzy set representation of the hazard severity and solved a fuzzy goal programming problem to determine allocations under either case. Community stakeholders may specify whether they wish to use resources to mitigate against the most-likely case, the best-case, the worst-case, or some other intermediate scenario by supplying three weights that sum to one.

Future work, which the authors are already pursuing, includes extending this approach to that of multi-hazards and multiple community performance measures.

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USE OF WEB-BASED COURSEWARE AND STUDENT PERFORMANCE

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ABSTRACT

Web-based courseware such as Blackboard and WebCT has been used widely as support for a traditional classroom format. Built on the technology acceptance model (TAM), which has been expensively tested in examining the use of various information systems in organizations, this study examines the use of web-based courseware and its effects on the student performance. It uses data collected from undergraduate students in the introductory course to information systems. The results of the study will provide valuable insights into how the constructs of TAM are related to performance in the context of web-based courseware.

INTRODUCTION

The technology acceptance model (TAM) posits that perceived usefulness (PU) and perceived ease of use (PEOU) are important factors that determine the user's attitude toward intention to use information systems (Davis, 1989). A key purpose of TAM is to provide a basis for tracing the impact of user perceptions of the system on use of the system. While many empirical studies have supported the predictive power of TAM in various settings of system use, most of them have measured actual system use through self-reporting or not measured actual system use. Since the ultimate objective of TAM is to predict actual system use, a study using more objective measures for actual system use is needed in order to add predictive power of the model. This study intends to help resolve this limitation of previous studies on TAM and extend the line of empirical research on TAM into web-based courseware.

Using data collected from undergraduate students in the introductory course to information systems, the study examines the constructs of TAM and the effects of actual system use on the student performance. It uses two objective measures for actual system use: frequency and consistency of use. The results of the study will provide valuable insights into how actual system use is related to performance in the context of web-based courseware, and contribute to the understanding of TAM with enhanced predictive power.

CONCEPTUAL BACKGROUND

Researchers in information systems have made efforts in identifying the factors that facilitate system use and formulating the factors into a model in a way that can help in explaining and predicting system use. Since Davis [2] proposed such a model called technology acceptance model (TAM), many researchers have tested and extended TAM in various settings of system use. A key purpose of TAM is to provide a basis for tracing the impact of user perceptions of the

system on actual system use. Figure 1 shows the research model based upon TAM. TAM posits that perceived usefulness (PU) and perceived ease of use (PEOU) are important factors that determine the user's attitude towards his or her intention to use and actual use of the system. Also, the model posits that the user's behavioral control and subjective norm influence his or her intention to use and actual use of the system. While previous studies have generally supported the predictive power of TAM, most of them have measured actual system use through self-reporting or not measured actual system use. Since the ultimate objective of TAM is to predict actual system use, a study using more objective measures for actual system use is needed in order to add predictive power of the model.

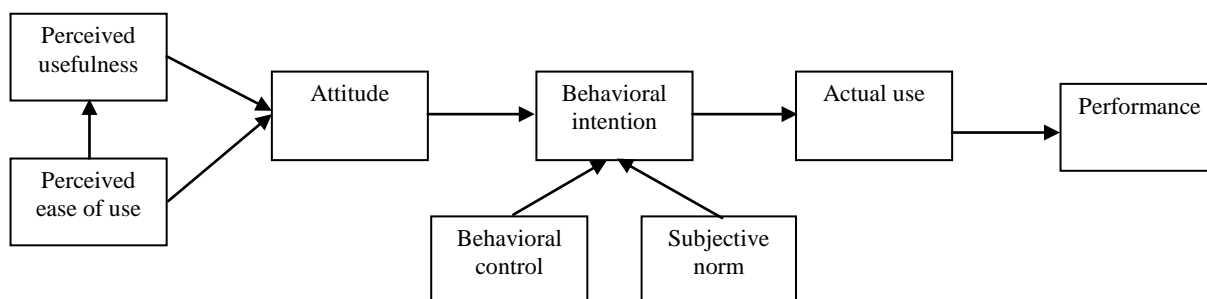


Figure 1. Research Model Based on TAM

The objective of the current study is to extend the line of empirical research on TAM in the context of web-based courseware. The study uses two objective measures for actual use of the system: frequency and consistency of use, and extends TAM by examining the effects of actual system use on performance. Taken together, this study intends to contribute to the understanding of TAM in the context of web-based courseware.

METHODS

This study uses a quantitative method in examining the relationships among the constructs specified in the research model. It uses data collected from a survey of students who used Blackboard for their course works and system use data generated by the system. Data for this study was collected from undergraduate students in four sections of an introductory information systems course offered in two semesters. The same instructor taught all four sections with the same class materials and used Blackboard as support for a traditional classroom format. The survey questionnaire contained multiple measurement items relating to each of the six constructs in TAM except the constructs of actual use and performance. It adopted scales that demonstrated good psychometric properties and internal consistency in previous studies. Each construct in the model was measured with multi-faceted items, and each item was measured by the extent of the respondent's agreement on the item.

In addition, two measures adopted from Baugher *et al.* [1] were used for actual use of the system: frequency and consistency of use. The frequency of use is the total number of hits that students make to the course site on the system over the semester. This total was obtained from the system one day before the final exam. The measure for consistency of use was not directly

provided by the system but it was computed by evaluating the number of hits accrued after one class but before the next class. When the student made no hit in the time between class meetings, he or she was assigned a '0' for that time period. When the student made at least one hit to the site during the time between class meetings, he or she was assigned a '1' for that time period. Since there were 30 time periods of this type over the semester (twice a week and fifteen weeks in a semester), this measure can range from 0 to 30.

The specific procedures of data analysis include confirmatory factor analysis for reliability and validity tests of each construct in the model and structural equation modeling and path analysis to estimate parameter values for the linkages between the constructs in the model. The study uses partial least squares as the tool for structural equation modeling. Structural equation modeling involves two phases. First, the measurement model is assessed. Second, once the measurement model has been shown to be adequate, the explanatory and predictive power of the model (i.e., the structural model) can be assessed.

RESULTS

The main results of this study will be the identification of any effects of actual use of web-based courseware on student performance. That is, the results will provide valuable insights into how the actual use of web-based courseware is expected to affect the student performance in the class. On a practical level, such understanding will prove a helpful viewpoint for those who want to improve actual use of web-based courseware as support for a traditional classroom format. On a theoretical level, the results will help resolve a limitation recognized in previous studies on TAM with enhanced predictive power. Taken together, this study will make a significant contribution to extending the line of empirical research on TAM.

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RECONCILING ENTERPRISE SECURITY CONCERNS WITH THE BYOD TREND

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ABSTRACT

Employees increasingly want to use their own mobile devices for work and they have demonstrated that when they can use devices of their choosing for work purposes it increases their morale and consequently augments productivity. At the same time, companies want to ensure that these mobile devices adequately secure corporate data. Companies need to find a balancing point between their security concerns and their employees' expectations of control over their mobile devices. The primary research question for this analysis concerns how enterprises can reconcile their own security concerns with the BYOD trend.

INTRODUCTION

Consumers now have a wider array of wireless devices available to them than ever before, many of which, including smartphones and tablets, have essentially the same capabilities as a desktop computer. Consumers tend to be very enthusiastic about their personal wireless devices and, perhaps inevitably, use them for work-related purposes. Businesses are increasingly taking advantage of this trend and enacting bring your own device (BYOD) policies, which, as the name implies, allows employees to use their wireless devices for work. BYOD is distinct from CYOD (choose your own device) in that the latter allows employees to choose from a variety of mobile devices offered by the company. Under CYOD the device is owned by the company rather than the employee [16].

While employees may be enthusiastic to use their latest model smartphone or tablet for work, there are a considerable number of risks associated with the BYOD trend that should give employers pause. To begin with, employers will have considerably less control over personally owned devices than they would over devices they provision themselves. Security of employee devices is a particular concern. Businesses would be well-advised to take steps to ensure that employee devices have adequate security software in order to protect the proprietary data within. Another security

concern is the possibility that the mobile device itself could be lost. If a lost device is not properly secured, at a minimum with a password, it could place both the personal data of the employee and the confidential data of the company and its customers at risk [4].

Companies have many choices available to them when choosing how to manage their BYOD policies. Simple policies companies can issue involve requiring employees to password protect their devices and providing usage guidelines to ensure that devices are used in manners that do not violate corporate policy. Devices used to store corporate data should also be encrypted to a credible standard, such as the Federal Information Processing Standard (FIPS 140-2), because companies are liable for the personal information of their customers [4].

More advanced steps companies can take include using mobile device management (MDM) or mobile application management (MAM) systems to remotely control the processes and content of employee devices. MAM focuses on controlling specific applications on mobile devices while MDM offers far greater control over the device itself. MAM and MDM systems can be used to enforce password policies, remotely install applications, track the physical locations of devices and remove corporate data stored on a device if it is lost or if a worker's employment ends. A third option is to retain data on a corporate network and require mobile devices to access the network through a remote application [4] [14].

Problem Statement

Employees increasingly want to use their own mobile devices for work and they have demonstrated that when they can use devices of their choosing for work purposes it increases their morale and consequently augments productivity. At the same time, companies want to ensure that these mobile devices adequately secure corporate data, creating a conflict because employees tend not be overly enthusiastic about having a corporate footprint on their personally owned devices, a feeling which is no doubt even greater when the burden of paying for the mobile contract is left with the employee [16].

Companies need to find a balancing point between their security concerns and their employees' expectations of control over their mobile devices. Employers have no shortage of options when it comes to device management solutions, including MAM and MDM, and will need to determine which policies and systems offer the greatest benefit to their organizations. Comprehensive MDM systems may provide superb levels of control over devices but at the expense of employee morale. Conversely, unenforced guidelines pertaining to password protecting devices will almost certainly be insufficient to protect the personal information of customers and leave the company liable for damages in the event of a data breach. This research will examine how enterprises can reconcile their own security concerns with the BYOD trend. The primary research question for this analysis concerns how enterprises can reconcile their own security concerns with the BYOD trend. Sub-questions to the primary question are:

- What policies are most effective for BYOD governance?
- What device or application management scheme best addresses the risks posed by BYOD?
- Where should companies draw the line between business and personal use of devices used in BYOD schemes?

We hypothesize that the content analysis will highlight the following:

- The importance of well-established and communicated BYOD policies, which will provision for the training of employees and plan for the loss or theft of devices, among other concerns.
- The necessity to use mobile device management systems to enforce password guidelines, track device usage and protect company data.
- Substantial areas of agreement regarding how much control over BYOD devices belongs to the employer and how much control is retained by the employee.

BRIEF LITERATURE REVIEW

The BYOD trend is growing by almost any measure. An estimated 95 percent of all mobile workers already use smartphones for business and the number of employee owned devices used in business is expected to exceed 1 billion by 2018 [4] [7]. More generally, 44 percent of Americans are estimated to be smartphone owners and 71 percent of them use their smartphones in the workplace [1]. The 2010 Mobile Device Management and Security Survey found that, among 21 percent of companies surveyed, half of their employees used smartphones and 87 percent of the companies expect the percentage to increase significantly [21]. A study of physicians found that 98 percent of respondents used smartphones and tablets for both professional and personal purposes [9].

The BYOD trend is characterized as a movement driven by the consumerist appetites of employees [2]. It is now common for workers to possess technology more sophisticated than the devices available from their workplaces and they may naturally prefer their own devices over those provisioned by their business. While younger workers in particular are credited with an appetite for using smartphones and tablets for work, other employees who first encounter these devices at work may increasingly choose to use them for both professional and personal uses [2] [5].

At present, a mere 36.5 percent of smartphones used in workplaces are owned by the businesses and it is likely that many employees may choose to use their own smartphones for business purposes even if its usage is restricted by the policies of their business; possibly opting to use their own personal, preferred smartphones even if one has already been provisioned to them by their company [5]. Businesses can choose to take advantage of these consumerist appetites in order to boost employee morale and productivity while simultaneously increasing the usage of recent technologies within the organization and reducing overhead expenditures related to the upkeep of company provisioned mobile devices [12] [4]. Many businesses have already chosen to embrace the BYOD approach. A 2012 survey performed by a security services vendor of its customers found that 76 percent of companies supported BYOD. The survey also demonstrated that larger companies were more likely to use the BYOD approach, with 75 percent of BYOD companies having 2,000 employees or more while 46 percent of BYOD companies had 10,000 employees or more. Half of these companies required employees to cover the full costs of their devices [19].

BYOD has demonstrated considerable benefits for the companies that embrace it. The improved capability of employees to perform tasks that would traditionally require the employee to be present in the office, faster communication between employees and possibly even reduced commuting costs [21]. Communication between employees can see marked improvement because 86 percent of employees always have their devices turned on while a similar percentage sleep next

to their devices. 15 percent of employees even bring their devices along on vacation [15]. Improved employee morale and productivity are also frequently cited benefits of BYOD, with one study finding that 74 percent of IT decision makers reported increased productivity after implementation of their BYOD programs [1] [8]. BYOD can increase employee morale by allowing companies to increase the flexibility they provide to their employees in terms of their working hours and their capabilities to telecommute [8] [19].

Despite the potential benefits posed by the BYOD trend, there are risks. One survey found that eight out of ten chief information officers believed permitting the use of smartphones in workplaces increased their business's vulnerability to attack [21]. At the same time a survey of physicians found that 75 percent of them encountered reluctance on the part of their hospitals to allow their mobile devices access to the hospital network because the devices used by the physicians were perceived as “less secure, less reliable, and costlier to deploy and support than desktop computers” [9]. The concerns of those reluctant to embrace the BYOD trend are well-founded.

The use of employee-owned mobile devices in workplaces presents inherent risks. A company's IT department may have difficulty monitoring employee devices and tracking what information these devices are retrieving from corporate databases [12] [3]. The personal use of devices by employees can present additional challenges. Employees who view their devices as their own property, even when used in the workplace, may be reticent to comply with company rules regarding use of the device and instead believe they can install whatever apps they please [4]. Generation Y employees, in particular, have been cited for failing to obey the BYOD policies of their companies and for storing proprietary data on their personal devices at a higher rate than members of other generations [15]. These attitudes may prove extremely problematic for companies because many apps fail security tests and could potentially be “trojanized” to gain access to company systems [3]. With these concerns in mind, it may be unsurprising that almost half of companies that allowed an employee-owned device to connect to the corporate network suffered a data breach. 50 percent of companies surveyed for another report admitted that corporate and employee owned devices may have been compromised without their knowledge [3] [12] [21].

Additional risks are posed when employees use networks outside the control of the employer. This is an especially strong concern regarding unsecured, wireless networks. Wi-Fi enabled smartphones are expected to increasingly become the targets of attacks traditionally targeted at laptop and desktop computers as well as new forms of attack tailored for smartphones [21]. The sooner companies get their BYOD security policies in order, the better prepared they will be to counteract emerging threats.

One survey found that 19 percent of organizations that lost a mobile device experienced a data breach afterward. 54 percent of respondents admitted that the lost device had not even been encrypted [6]. Data breaches have an average cost per record of \$136 globally and \$275 in the United States, costing an average of \$5.4 million per incident [10] [22]. Data breaches also involve indirect costs, including damage to customer relationships, the cost to investigate the incident and possible costs associated with audit compliance and torts, if legally reasonable efforts were not made to secure the lost data [10] [22] [21].

It is entirely possible for a data breach to land a company in legal trouble. This is especially true for companies involved in the health sector, which are subject to the Health Information Portability and Accountability Act of 1996 (HIPPA) and the HITECH Act. Together, HIPPA and HITECH require hospitals to conduct security assessments and address vulnerabilities. These acts also require entities that “collect or retain private health information” to comply with rules intended to prevent unauthorized disclosure [21] [9]. Difficulties remain even after companies have taken steps to secure personally owned devices. One survey found that, even among respondents highly likely to be IT professionals, 36 percent of respondents had failed to password protect their devices [4]. A more general survey found that nine out of ten respondents had failed to password protect their devices and that nearly half of respondents allowed other users access to the personal devices they used professionally [15]. Respondents to the same survey answered that no users within their organizations had a “thorough understanding” of mobile data risks and acted upon that understanding [4]. A separate study surveying a purportedly “security-savvy” audience found that 41 percent were carrying unprotected, sensitive information on their mobile devices. Of these respondents, the organizations of 70 percent had standards for mandatory data encryption, meaning that 11 percent of the aforementioned respondents were in violation of the standards of their own companies. Interestingly, only 36 percent of respondents felt that FIPS certification was necessary for encryption technology [6].

One study measuring the changes in stock prices for companies that suffered data breaches found that, although the stock prices of these companies decreased significantly in the aftermath of security breaches during the six years prior to 9/7/2001, security breaches did not seem to have a significant effect on stock returns in the following years. This trend indicates that, at least among investors, security breaches are perceived as a nuisance rather than as a serious threat. These findings may account for some of the poorly designed and badly enforced policies regarding mobile device security [11].

Companies need to take greater steps to harness and take control of the BYOD trends occurring within their organizations. Immature and poorly communicated policies place the data of the company and its employees and customers at risk, endangering the reputation and profitability of the company. Eddy [7] found that 65 percent of respondents identified their companies as either having failed to communicate any policy or official guidelines regarding BYOD or that their company banned the use of personal devices altogether. 71 percent of businesses employing BYOD surveyed by one study had no policies or procedures in place designed “to ensure security” [1]. Among the companies surveyed by ITIC [12], 34 percent admitted to having “no way of knowing” if an employee-owned device had a security issue or claimed they “do not require” that users inform them if a security issue with their device occurs. 56 percent of these companies have no plan in place to handle lost or stolen devices and the same percentage admit they are taking no steps to upgrade their security measures [12]. The lack of response planning seems particularly ill thought out when one considers that the loss of a device often heralds a company data breach and companies with data breach response plans in place experience breaches 20 percent less costly than their less prepared contemporaries [10].

Due to the rapid pace at which mobile devices are introduced to the market, the “allowable devices” under a BYOD policy will change frequently, making it important for the employer to establish strong guidelines for permissible devices. The plan should also cover what actions will

be taken should the device be lost or the owner's employment terminated and what should be done in the event of a data breach. For the purpose of accountability, the company may also choose to present employees with signed agreements upon the completion of training [4] [2] [22] [9] Munroe, 2013; [1]. Companies should consult with their legal counsel as they develop their plans in order to ensure their plans satisfy legal requirements [8].

Companies should take steps to ensure their security measures are adequate. This should begin with a risk assessment that pays special attention to access attempts from IP addresses originating from outside the “trusted network” of the organization [9]. Companies that handle sensitive information over mobile devices should analyze not just who is accessing what data but also where they are accessing it. Employees with access to protected health information on mobile devices, for instance, should be instructed to take care that they not access that information in public areas where it can easily be observed [9]. Companies should be careful to outline in their governance plans how these sensitive forms of data should be stored, encrypted and accessed on mobile devices.

The review of literature related to BYOD concerns highlights several points of consensus. There is substantial agreement that BYOD increases employee productivity, connectivity, technological proficiency and reduces overhead expenditures. BYOD exposes companies to many security risks, which are both technological and rooted in the behaviors of employees. Companies need not even permit BYOD to be exposed to these risks. Employees are likely to use their own devices for work even if it violates company policy, especially Generation Y employees. In order to combat these risks, companies are advised to enact BYOD governance policies and properly educate their employees on these policies. These policies should be backed up with appropriate mobile device or application management systems. These device management systems should properly balance security against usability. If devices are so locked down that they are practically inoperable, BYOD will lose much of its appeal for employees and consequently for organizations as well.

RESEARCH DESIGN

This research is concerned with how enterprises can reconcile their security concerns with the BYOD trend. More specifically, the research intends to address (1) what policies are most effective for BYOD governance, (2) what device or application management schemes best address the risks posed by BYOD and (3) where companies should draw the line between business and personal use of devices used in BYOD schemes.

Although BYOD remains an emerging trend there are a large number of articles that have been published concerning the topic. The emergent nature of this area of study lends itself well for exploratory qualitative research which can be used to establish a foundation for theory from which more detailed studies. Among qualitative methodologies, content analysis is best-suited for this research. Content analysis can be used to identify themes and patterns within a body of work. Although primarily qualitative in nature, the content analysis methodology also allows for the leveraging of quantitative data in order to aid in analysis. This quantitative analysis comes in the form of tabulating the frequencies of characteristics that appear in the works being studied in order to extrapolate trends that bear further analysis. Themes and patterns highlighted by the content analysis may later become the basis for surveys designed to procure data that could lead to highly

meaningful quantitative analysis of the BYOD trend and its accompanying security concerns.

Articles for the content analysis were acquired from searches of two electronic journal databases. Searches were based on a keyword search for "bring your own device" and limited to peer-reviewed articles published after 2012. Additional articles were located with a "mobile device management" search. Only articles with full text available were included. Only articles whose focus is pertinent to the research questions will be retained.

Sampled articles were reviewed in order to ensure relevance for inclusion and were categorized for high, medium or low relevance to BYOD security concerns. Relevant articles were scrutinized in order to determine the major issues present that relate to BYOD security concerns. 32 articles passed the relevancy test which provided an adequate sample. These issues were used in the creation of a codebook and were operationally defined as the units of analysis.

Issues for the initial framework have been drawn from the articles included in the literature review. This framework was modified as issues from the sample articles were identified and included for analysis. The working framework for issues that were used for the codebook were:

Organizational Policies

- Companies should enact well-designed BYOD policies in order to protect their own data and that of their customers and employees.
- Companies should have plans in place to follow in the event of a data breach.
- Relevant stakeholders should be considered when drafting the BYOD policy.
- BYOD policies should be developed with a focus on users, not an exclusive focus on devices.
- Companies should perform assessments of mobile device risks.
- Companies should audit their device management systems once they are in place.
- Companies should conduct a workflow analysis in order to determine where employees are working with their mobile devices and what sensitive data they are accessing.
- Companies should decide whether or not to provide in-house tech support for employee-owned devices.
- Companies should review BYOD implementation and allow for employee feedback and ongoing improvements.

Device Policies

- Devices should be encrypted to the Federal Information Processing Standard (FIPS 140-2)
- Companies should establish procedures for notification after the loss or theft of devices.
- Companies should determine whether or not to restrict certain websites or applications on employee devices.
- Companies should require that all devices used as part of a BYOD scheme be enrolled on a centralized mobile device management system.
- Smartphones should be used to track and monitor employee activities and movements.
- Dual-identity phones should be used to separate business and personal information.
- Only selected applications should be allowed access to a company's VPN.
- Companies should determine allowable devices for employees.

- Companies should allow employees to use whatever devices they choose for BYOD.
- Companies should account for compatibility issues between their device management systems and employee devices.
- Device policies should satisfy regulatory requirements regarding proper storage of documents.
- Devices should be capable of being locked remotely, disabling all device features.
- Companies should have policies in place to retrieve devices from employees if they must be preserved for legal reasons.
- Jail-broken operating systems should not be permitted in BYOD programs.

Employee Policies

- Employees should receive training on the BYOD policies and procedures of their company and their responsibilities within the BYOD scheme of their company.
- Employees should be required to sign agreements to abide by the BYOD policies of their organizations after completion of training.
- Employee participation in BYOD should be optional.
- Companies should decide whether they will reimburse employees for their mobile devices or if the employee will be responsible for some or all of their mobile device's costs.
- Companies should address what to do when employees cannot afford devices with adequate security features.
- Companies should address whether or not both personal and business use of smartphones is permitted.
- Companies should establish app stores for their employees to provide them with approved apps.
- Employees should be made aware of their privacy expectations under BYOD give signed consent. This is important for corporate auditing of BYOD devices.
- Executives should not be exempt from BYOD policies.

Data Policies

- Companies should establish criteria for what data on the device belongs to the employer.
- Companies should stipulate what data is allowed on mobile devices.
- Companies should determine what level of access devices have to company systems.
- Companies should develop the capacity to detect when BYOD or other security breaches have affected the rest of their IT infrastructure.
- Sensitive data on devices should be encrypted. Especially . . .
 Personal Health Information (PHI)
 Trade Secrets
 Confidential Customer Information
 Financial Data
 Attorney-Client Privileged Information
- E-mails sent or received by mobile devices should be encrypted.
- Business and personal data should be partitioned or “containerized”
- Smartphones should be required to interface with company servers remotely, bypassing the need to store data on the phone itself.
- Data access should be restricted based on time and place as well as the identity of the user.

- Companies should establish a policy for removing business data from the personal device when necessary, such as when an employee quits the company or the device is lost.
- Mobile device management systems should include the ability to remotely wipe employee devices.
- Companies should decide if device memory will be wiped in full or if personal data will be left alone.
- Companies should establish backup archives for information contained on mobile devices.
- Company policy should contain provisions for accessing information and documents on devices.
- Data access should be monitored and logged, as should the devices connected to the network.

Device Usage Guidelines

- Devices should be password protected.
- Passwords should be strong.
- Employees should never leave mobile devices unattended in public places.
- Employees should not respond to spam or other unsolicited or suspicious emails.
- Employees should not connect to unsecured Wi-Fi networks
- Employees should be required to install and maintain anti-virus and anti-malware applications on their personal devices.

The 16 coders were divided into two groups. Then one coder from each group was randomly paired up with a coder from the other group. Each pair of coders was then assigned the exact same four articles to analyze. To confirm the stability of the coding schema an independent t-tests was performed to determine if the average percent agreement for each group of two coders was or was not statistically different. Reproducibility is addressed by measuring the agreement between each of the coders and the primary researcher. The use of the appropriate reliability coefficient calculation is important. However, if the coders are consistently making incorrect judgments about the presence or absence of the issues in the article being coded the level of reproducibility will be negatively affected [13]. The primary researcher improved the reproducibility of this research by placing emphasis on improving the operational procedures used to properly code the content analysis articles. Focusing on the underlying classifications scheme, the operational definitions for coding categories, and the directions that guide the coding process directly improves the quality of judgment-based data [20].

To measure the strength of the research method employed a coefficient of agreement calculation was completed. The coefficient most commonly used in content analysis due to its applicability and ease of use is percent agreement [20] [13] [18]. Conversely, this coefficient has been identified as having the potential to over-inflate the level of agreement due to “chance agreement” [18]. Chance agreement is directly impacted by the number of coding decisions. As the number of issues in the codebook increases the probability of chance agreement decreases [20] [13].

Since this research had 56 issues, chance agreement was not seen as a confounding factor. Therefore, percent agreement was selected as the inter-rater reliability coefficient. An agreement is defined as the two judges, the primary researcher and the coder, found the issue in the article or if both of them agreed the issue was not present in the article. For both the pilot and full study the

percent agreement for each of the 24 coders was calculated twice. First, the coder's overall level of agreement with the primary researcher was measured. This was accomplished by totaling the number of agreements for each of the articles coded then dividing by the total number of issues 53. Then the coder's percent agreement average was computed for all the articles coded. However, according to Neuendorf, reliability coefficients must be reported separately for each and every measured variable [18]. Therefore, the second percent agreement measurement calculated the coder's level of agreement for each issue. To calculate this figure the total number of agreements was divided by the number of articles coded. Once again the coder's percent agreement average was computed across all of the issues. Each coder's two measurements of percent agreement were then plotted on a separate histogram. These two distributions allowed the researcher to calculate a confidence interval for the computed level of percent agreement. From these two confidence intervals, the overall reliability between the judges was established allowing the primary researcher to make inferences about the results.

RESULTS AND ANALYSIS

Four co-researchers were each assigned a subset of the 32 articles to address the potential for misinterpreted identified issues. Each co-researcher was given 8 articles to review. Amongst the four co-researchers, only two of them disagreed with the primary researcher in regards to the presence of an issue within an article. The four co-researchers also reviewed the coding schema to check for syntax or spelling errors and to ensure there was no redundancy across the 56 issues.

A sub-sample consisting of three of the 32 articles was selected to conduct a pilot study. Each of the 16 coders independently coded each article included in the sub-sample. This pilot study was conducted to develop a "valid, reliable, and useful coding schema" by considering three diagnostic measures [18]: 1.) The identification of problematic measures, 2.) The identification of problematic categories, 3.) The identification of problematic coders. To identify problematic measures the percent agreement for each article amongst the 16 coders and the primary researcher was computed. The overall percent agreement for each article was calculated by dividing the total number of agreements by the total number of issues. Then each coder's average percent agreement amongst the three articles was determined. From this calculation, the ability to properly analyze article three was identified as problematic.

The second diagnostic measure examined the average percent agreement per issue for each of the 16 coders. This measure was calculated by adding the total number of agreements for each issue across the three articles. The sum was divided by the number of articles coded. Then an overall percent agreement was computed by averaging all of the coders' respective scores per issue. Twelve issues were identified as problematic.

The identification of problematic coders was accomplished by re-analyzing the measurement utilized to examine problematic issues. The average percent agreement was calculated across all the issues for each coder. This measurement allowed the primary researcher to identify any potential rogue coders. The average percent agreement per coder was calculated by adding up each coder's percent agreement scores for each issue and then dividing this sum by 56. Five coders scored below the lower bound of the confidence interval bringing the total number of problematic coders to six.

Table 1: Reliability Coefficient of Each Variable

| Issue | Reliability Coefficient |
|--|--------------------------------|
| Companies should establish procedures for notification after the loss or theft of devices | .9167 |
| Companies should establish a policy for removing business data from the personal device when necessary, such as when an employee quits the company or the device is lost | .9167 |
| Employees should receive training on the BYOD policies and procedures of their company and their responsibilities within the BYOD scheme of their company | .8750 |
| Companies should establish criteria for what data on the device belongs to the employer | .8750 |
| Companies should allow employees to use whatever devices they choose for BYOD | .8750 |
| Mobile device management systems should include the ability to remotely wipe employee devices | .8333 |
| Companies should require that all devices used as part of a BYOD scheme be enrolled on a centralized mobile device management system | .8333 |
| Data access should be monitored and logged, as should the devices connected to the network | .8333 |
| Employees should be made aware of their privacy expectations under BYOD give signed consent. This is important for corporate auditing of BYOD devices | .8333 |
| Employees should be required to sign agreements to abide by the BYOD policies of their organizations after completion of training | .7500 |
| Companies should enact well-designed BYOD policies in order to protect their own data and that of their customers and employees | .7500 |
| Companies should decide whether they will reimburse employees for their mobile devices or if the employee will be responsible for some or all of their mobile device's costs | .6667 |
| Relevant stakeholders should be considered when drafting the BYOD policy | .6667 |
| Business and personal data should be partitioned or “containerized” | .6667 |
| Companies should review BYOD implementation and allow for employee feedback and ongoing improvements | .6250 |
| Companies should decide if device memory will be wiped in full or if personal data will be left alone | .6250 |
| Sensitive data on devices should be encrypted. Especially . . . | .5833 |
| Companies should determine whether or not to restrict certain websites or applications on employee devices | .5833 |
| Companies should stipulate what data is allowed on mobile devices | .5833 |
| Company policy should contain provisions for accessing information and documents on devices | .5833 |
| Devices should be password protected | .5833 |
| Companies should account for compatibility issues between their device management systems and employee devices | .5417 |
| Employees should be required to install and maintain anti-virus and anti-malware applications on their personal devices | .5417 |

This content analysis initially documented 24 latent issues across the 32 articles identified during the sampling procedure. These 24 issues and their reliability coefficients are displayed in Table 1. One article was selected to be reviewed by all the coders to provide a measurement of inter-rater

reliability. From this assessment 1 of the 24 issues were identified as unreliable. The remaining issues give us a strong indication of what the main BYOD issues that need to be addressed are as shown in Table 2.

TABLE 2: ISSUE RELEVANCE

| Issue (Underlying Factor) | Count |
|--|--------------|
| Companies should enact well-designed BYOD policies in order to protect their own data and that of their customers and employees (Organization) | 31 |
| Employees should receive training on the BYOD policies and procedures of their company and their responsibilities within the BYOD scheme of their company (Employee) | 27 |
| Mobile device management systems should include the ability to remotely wipe employee devices (Data) | 27 |
| Companies should establish a policy for removing business data from the personal device when necessary, such as when an employee quits the company or the device is lost (Data) | 27 |
| Companies should determine whether or not to restrict certain websites or applications on employee devices (Device) | 26 |
| Companies should establish procedures for notification after the loss or theft of devices (Device) | 20 |
| Data access should be monitored and logged, as should the devices connected to the network (Employee) | 19 |
| Devices should be password protected (Usage) | 19 |
| Companies should stipulate what data is allowed on mobile devices (Data) | 16 |
| Business and personal data should be partitioned or “containerized” (Data) | 15 |
| Companies should decide if device memory will be wiped in full or if personal data will be left alone (Data) | 14 |
| Company policy should contain provisions for accessing information and documents on devices (Data) | 14 |
| Companies should account for compatibility issues between their device management systems and employee devices (Device) | 13 |
| Companies should decide whether they will reimburse employees for their mobile devices or if the employee will be responsible for some or all of their mobile device's costs (Employee) | 13 |
| Companies should establish criteria for what data on the device belongs to the employer (Data) | 11 |
| Companies should require that all devices used as part of a BYOD scheme be enrolled on a centralized mobile device management system (Device) | 11 |
| Companies should allow employees to use whatever devices they choose for BYOD (Device) | 9 |
| Employees should be required to sign agreements to abide by the BYOD policies of their organizations after completion of training (Employee) | 9 |
| Relevant stakeholders should be considered when drafting the BYOD policy (Organization) | 8 |
| Companies should review BYOD implementation and allow for employee feedback and ongoing improvements (Organization) | 8 |
| Employees should be made aware of their privacy expectations under BYOD give signed consent. This is important for corporate auditing of BYOD devices (Employee) | 7 |
| Sensitive data on devices should be encrypted. Especially . . . (Data) | 7 |
| Employees should be required to install and maintain anti-virus and anti-malware applications on their personal devices (Usage) | 7 |

There are 11 issues that are reported as highly reliable. The remaining 12 issues must also be addressed, but as can be seen their respective reliability rating is below 70%. Such a low reliability rating causes the assessment to become difficult to interpret [18]. Nevertheless, this research was exploratory in nature making it difficult to maintain objectivity during the process of issue identification. Therefore, these issues are still reported.

DISCUSSION

There is no consistency in the underlying factors which cause these issues to be relevant. For example, the five most relevant issues are driven by four distinct factors. Even when the top ten most relevant issues are reviewed all five different underlying factors are identified as the reason for their relative importance. Therefore, the conclusion reached from this research is that to effectively manage BYOD an organization must not focus on one underlying factor. Instead, a holistic management approach must be taken utilizing organizational, device, employee, data and device usage policies. From the analysis, one interesting finding is worth mentioning. The first is that of the top ten most relevant issues five of them are driven by data policy factors and eight of the twenty-three or one third of all issues are data policy related. The researcher is hesitant to identify this as a clear answer to the goal of this research. However, it can be stated that the effective management of BYOD requires the dedicated support of the entire organization with possibly an emphasis on data policies.

The number one issue, Companies should enact well-designed BYOD policies in order to protect their own data and that of their customers and employees was not a surprising finding. But from there the underlying issues tend to follow the broad set of issues laid out in the codebook; thus, further establishing that the right issues have been extracted and researched in this study. The low frequency score of the last three significant issues (privacy, sensitive data, and malware) demonstrates the lack of attention placed on them in the research, yet they are some of the top issues you hear about for BYOD in the popular press. This adds support to the motivation for completing this research. The development and implementation of an effective BYOD policy has been discussed across a wide variety of literature. Conversely, the topic of managing the BYOD policy across the space of the device, data, employee and usage factors has not been adequately addressed in combination. Each of these issues covers a different aspect of managing a BYOD policy.

The 23 issues across the five themes identified in this research should be studied further. Future research could be conducted through case studies, surveys and could possibly be introduced in their entirety to an individual organization newly implementing a BYOD policy. This future research should help identify the underlying issues and address what are the core factors leading to successfully managing BYOD in organizations.

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INTRODUCTION TO TERRORISM FOR MANAGERS

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ABSTRACT

Most persons are well aware of the nature and danger of terrorism, although they haven't had the least inclination to define what the term actually means. Throughout history, there have been many examples of terrorism as a threat to individual freedom and national security, and those threats have taken the form of a wide variety of actions resulting in large-scale losses of life, destruction of public, private, and personal property, widespread illness and injury, displacement of large numbers of people, and devastating economic loss. There are several dimensions to terrorism, including its very nature, cause, perpetration, targets, methods, and defense against it, and numerous papers, reports, and books have been published on the subject. However, a civilian awareness of methods for defense against terrorism has yet to be developed and most businesses, institutions, and other agencies have little preparation or knowledge of a possible response to a terrorist attack. Business and institutional management has a responsibility to stakeholders, employees, customers, and the general public for an effective response in the event of a terrorist attack. An introduction to the essential methods for establishing an appropriate response to terrorism is the subject of this paper.

INTRODUCTION

Terrorism is a tactic for eliciting fear among its targets for a defined purpose; it is used in times of peace and conflict by nation states, organized groups, and individuals. Most people in the course of everyday affairs experience a minor form of terror from clergy, teachers, doctors, and criminals. This kind of terror, however threatening it may be, is not the subject of this paper. We are going to investigate the use of violence for political, religious, or ideological reasons against noncombatant targets with the ultimate objective of causing societal change, even though the exact nature of that change varies widely and at times would seem to be ill-directed. Historically, terror was used extensively for totalitarian domination and revolution against it. In more modern times, terrorism has addressed selected targets. We are going to refer to domination, revolution, and selectivity as the "old terrorism." The *new terrorism* is aimed at a broad spectrum of society so that it causes as many casualties as possible and a widespread societal disruption. [5]

The precise forms that terrorism can take include any or all of the following:

- Threats of terrorist activity
- Assassination
- Kidnapping
- Hijacking
- Bomb scares and bombing
- Cyber disruption and warfare
- Use of chemical, nuclear, and radiological weapons

Moreover, terrorist acts may result from a terrorist organization or a "lone wolf" cell structure. The organization may have a hierarchical or horizontal structure and span multiple countries and be comprised of leaders, planners, trainers, specialists, and large groups of individuals that actually execute an asymmetrical form of warfare, wherein a weaker group attacks a stronger group outside of the conventional form of violence. The RAND terrorist database reflects that 96% of the persons killed by terrorist attacks in the US, Russia, and Eastern Europe in the period 2000-2010 were committed by

Muslim terrorists. The terrorist objectives have evolved from political demands to a destruction of modern society. [6,8]

CAUSES OF TERRORISM

Terrorism has a long and extremely violent history, and there are differing views of the subject matter. It is important to note that one person's terrorist is another's freedom fighter. Even residents of countries in which the violence occurs commit some terrorist acts, although most acts of terrorism originate from within foreign borders. Even though most terrorism is rooted in the Muslim community, radical Christian groups have supported the bombing of abortion clinics. There are many root causes that exist in the literature. Here are a few:

- *Religion* – Fanaticism inherent in an ideological focus
- *Oppression* – Opposition to a governmental state-of-affairs
- *Historical grievances* –Targeting of governmental views as being responsible for historical injustices
- *Violations of international law* – Infringement of a right valued by the terrorist
- *Relative deprivation* – Limited relative economic opportunities
- *Financial gain* – Kidnapping or hostage taking for ransom
- *Racism* – Dehumanizing adversaries
- *Guilt by association* –Terrorism against groups or individuals sympathetic to an unpopular cause of a terrorist group
- *Narcissism* – Defensive grandiosity caused by personal inadequacy
- *Communication and publicity* – Killing adversaries or innocent civilians to promote a particular cause

Even though the causes of terrorism are varied and diverse, many scholars refer to terrorists as individuals in search for an ascribed identity – i.e., an identity created for oneself, as opposed to an identity assumed through innate human characteristics or attribution by others. Most modern societies focus on unacceptable levels of death or destruction caused by terrorism as a means of identifying the individuals involved. Both men and women have been engaged in terrorism, and women have occasionally been leaders. However, most leaders have been men, and women have been followers. Less physical roles, such as making bombs explode, are particularly appropriate to women since they are less closely scrutinized than men. Most male terrorists are between the ages of 19 and 23 and women over 24. Many female terrorists are widows of men killed by the opposition (sometimes referred to as “black widows”).

FORMS OF TERRORISM

A useful definition of terrorism, to frame the various forms it could take, is that it is the calculated use of unlawful violence or threat of unlawful violence to inculcate fear; intended to coerce or to intimidate governments or societies in the pursuit of goals that are generally political, religious, or ideological. [7 p. 2] The vectors of action by terrorists are political, psychological, violent, and deliberate action. *Political terrorism* reflects a deeply held grievance over some form of injustice. *Psychological terrorism* is intended to produce a negative psychological effect on a target population. *Violent terrorism* intends to produce a physical effect that can contribute to other forms of activity. *Deliberate terrorism* is purposeful selection of a target audience, which may appear to be random, but is designed with a terrorist objective. [op cit. p.1-4] Here are the various forms of terrorism:

- Threat or hoax
- Arson
- Sabotage

- Bombing
- Chemical/biological
- Kidnapping
- Hostage taking
- Hijack-seizure
- Raid or ambush
- Assassination
- Weapons of mass destruction (WMD)
- Maritime threats
- Suicide tactics

The forms of terrorism may be introduced to disrupt or dismantle a variety of activities and facilities, such as practices/procedures/routines, residences and workplaces, transportation facilities, and the very facilities designed to protect against terrorism.

TERRORISM MANIFESTATIONS

Terrorist threats can be grouped into four distinct categories: explosions, biological threats, chemical threats, and nuclear blasts. The effective manager should provide countermeasures and response scenarios in each of these categories. [1]

Explosions

One of the most common forms of terrorist weapons is explosive devices, since information on their construction is readily available. Moreover, explosive devices are easily detonated from remote locations or by suicide bombers. Surveillance is an effective countermeasure, as well as the identification of packages containing bombs. Here are several ways of identifying suspicious packages:

- Unexpected from an unfamiliar source
- Have no return address
- Marked with restrictive denotations
- Have protruding wires
- Variance between return address and postmark
- Unusual weight for the size
- Unusual labeling
- Have excessive packaging material
- Have misspellings of common words
- Addressed to someone no longer in your organization
- Have incorrect titles
- Not addressed to a specific person
- Have hand-written addresses

Telephoned bomb threats are also common. The usual procedures apply, such as keeping the caller online and notifying the proper authorities.

Biological Threats

Biological agents are organisms that can kill or incapacitate people, livestock, and crops. The most common threats are bacteria, viruses, and toxins. Agents in this category are easily dispersed by spraying them into the air, through animals, and through food and beverages. Here are the most common examples to guard against:

- Aerosols
- Animals
- Food and water contamination
- Person-to-person

Limiting physical contact, filtering systems, and personal hygiene are effective countermeasures to be implemented, since governmental facilities have a definite lag time.

Chemical Threats

Chemical agents are poisonous vapors, aerosols, liquids, and solids with dangerous properties. Chemical agents may be released via aircraft, boats, and vehicles. Chemical agents may have delayed effect and may dissipate rapidly. Physical and organizational countermeasures are effective against chemical threats.

Nuclear Blast

A nuclear attack is characterized by intense light and heat. However, dirty bombs are particularly convenient to terrorists and contain low-level radiation components as well as various forms of metal debris. Radiation poisoning can have a delayed response and medical countermeasures are commonly available. In the event of a nuclear attack or incident, distance, shielding, and time are particularly good defenses.

PRIMARY RECOMMENDATIONS

Recommendations for the protection of public health are readily available from government reports and are generally grouped into biodefense, food and water safety, citizen self-help, and a national readiness strategy. The government can help with preparedness through a public health system and definitive communications in the event of a terrorist attack, or with an effective alert system.

Business also should have a role in preparing employees and insuring business continuity. A terrorist attack could easily disrupt a supply chain with serious economic consequences.

GOVERNMENT RESPONSE

Leadership in the event of a terrorist attack must come primarily from government – at the federal, state, and local levels. However, there are things that individuals and businesses can do to protect their respective domains. Self-protection should involve the purchase of civil defense items, such as filter masks, safe rooms, and emergency kits. Knowledge of an appropriate response to an attack is of prime importance, and this knowledge can be obtained through publicity and familiarization with the threats of an attack. [2,3]

As stated in the US Strategy for Counterterrorism, core principles, building security partnerships, applying counterterrorism tools and capabilities appropriately, and building a culture of resilience guide the US position. [4] Governed by the rule of law, the core principles are summarized as:

- Respect for human rights
- Encouraging responsive governance
- Respect for privacy rights, civil liberties, and civil rights

- Balancing security and transparency
- Upholding the rule of law

Security partnerships are:

- Accepting varying degrees of partnerships
- Leveraging multinational institutions

Applying counterterrorism tools and capabilities appropriately include:

- Pursuing a “whole of government” effort
- Balancing near and long-term counterterrorism considerations

Building a culture of resilience necessarily involves:

- Building essential components of resilience

The four areas of focus provide the foundation for an extensive set of “overachieving” goals for the nation that include protecting the American people and homeland, disrupting terrorist organizations, preventing the acquisition of weapons of mass destruction, the elimination of safehavens, building enduring partnerships, degrading links between terrorist organizations and affiliates, diminishing the drivers of violence, and the elimination of enabling means for terrorist organizations.

SUMMARY

This paper defines terrorism and gives its causes. The forms of terrorism are described, and its destructive form is explored. The subject of a proper response and government support are covered. The subject matter is preliminary but necessary for a proper business response to terrorism.

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POSITIVE AND NEGATIVE AFFECT ASSOCIATED WITH WORK-FAMILY-SCHOOL CONFLICT

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ABSTRACT

The goal of this study is to find the Positive and Negative affect associated with work-family-school conflict. We expand a previously developed instrument to include not only work-family and family-work conflict, but also to include work-school, school-work, family-school, and school-family conflicts. Also, we determine which one of the conflicts were the best predictors of negative and positive affects as measured by the shortened version of the instruments, known as PANAS.

Keywords: positive and negative affect, work-family-study conflict

INTRODUCTION

In our world of globalization and 24 hour stimulation, the increased demand for more productivity from fewer workers, non-traditional college students have another source of conflict, school, in addition to work-family conflict. Approximately, four out of five part-time students have jobs, and over 50% of full-time students work. One of the most notable changes in higher education has been the growth of adult students, growing at a greater rate than traditional students with ages 18 to 22 years of age. Of the 17.6 million undergraduate college students, nearly 40% of higher education students are at least 25 years of age, and 25% are older than 30 years of age. Further, by 2019, the number of students at least 25 years of age is estimated to grow another 23% (National Center for Educational Statistics, 2008 [25]; Hessep, 2011 [18]).

Because of these multiple demands that students experience as employee, parent, spouse, and student, interrole conflict exists. Interrole conflict refers to the inability to effectively participate in one or more roles because of concurrent involvement in other roles Greenhaus & Beutell,

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1985 [14]; Stoeva, Chiu, & Greenhaus, 2002 [32]; Cheng & McCarthy, 2013 [9]. The simultaneous demands of at least two roles can create conflict (Katz & Kahn, 1978 [22]).

The impact of interrole conflict, both on and off the job, has been well-documented. Research has found that there is an inverse relationship between interrole conflict and satisfaction (Allen, Herst, Bruck, & Sutton, 2000 [1]), anxiety and fatigue (Greenhaus & Beutell, 1985 [14]), and turnover intention as related to work-family conflict (Karatepe & Baddar, 2006 [20]; Greenhaus et al., 2001 [15]).

Interrole conflict has a multitude of influences on the individual. It has been confirmed that interrole conflict creates stress, which in turn, can lead to poor performance and depression (Home, 1998 [19]; Markel & Frone, 1998 [23]; Ratelle, Vallerand, Senecal & Provencher, 2005 [29]).

With only a handful of exceptions (Biggs & Brough, 2005 [4]; Giancola, Grawitch & Borchert, 2009 [11]; Gigliotti, 2007 [12]; Gilbert & Holahan, 1982 [13]; Home, 1998 [19]; Kirby, Biever, Martinez, & Gomez, 2004 [21]; Brunel & Grima, 2010 [7]; McNall & Michel, 2011 [24]); Olson, 2014 [28]), past research on interrole conflict has limited itself predominantly to conflict between work and family and family and work (Casper, Eby, Bordeaux, Lockwood, & Lambert, 2007 [8]), and these interrole conflicts for college undergraduate and graduates. This lack of research extends across cultures (Brunel & Grima, 2010 [7]) and to secondary school students (e.g. Barling, Rogers, & Kelloway, 1995 [3]; Wertz, 1988 [38]) and investigation of both positive and negative impacts of cumulative work-school demands (McNall & Michel, 2011 [24]). Of these studies, only one (Olson, 2014 [28]) examined work-family-school conflict. That is, it examines the impact of work on family, family on work, for example, the impact of one on the other in each direction.

Affect, both positive and negative, has been well-studied in a variety of settings with numerous measures. Both positive and negative affect, including alternation between the two, contribute to creativity (Baas, De Dreu, & Nijstad, 2008 [2]; Bledow, Rosing, & Frese, 2013 [5]). There has been evidence that daily stress results in NA reactivity, where reactivity refers to intraindividual variation in NA as a result of daily stress that accumulates over time or “stressor pile-up”. There was no association between PA and stressor pile-up (Schilling & Diehl, 2014 [30]). Research supports the conclusion that experiences of daily stress are inversely related to physical and psychological health (Stawsk, Sliwinski, Almeida, & Smyth, 2008 [26]).

A review of the research literature found that there is little research which has examined the relationships between affect or mood and interrole conflict, specifically conflicts among work, family, and school. Only one empirical article could be located which examined both affect and interrole conflict, specifically work-to-family and family-to-work conflict. Ng and Feldman

(2014 [27]), found that WFC and FWC were both related to negative mood and chronic insomnia for two career couples in the United States and Singapore.

Given the lack of research on affect and interrole conflict and the limited research on work-family-school conflict, there were three purposes of this study. Because of the limited research on work-family-school conflict, there were almost no instruments to measure work and family conflicts with school. Therefore, one purpose was to expand the Gutek, Searle, & Klepa (1991 [16]), instrument to include not only work-family and family-work conflict, but also to include work-school, school - work, family-school, and school-family conflicts. The second purpose was to determine which of the conflicts were the best predictors of negative and positive affect. The PANAS, one of the most widely used measures for positive and negative affect was used. The original PANAS was developed by Watson, Clark, & Tellegen (1988 [36]). Thompson, (2007 [33]), developed a shortened version with acceptable internal consistency, and the latter was used in this research. The third purpose was to examine using a dependent variable, net affect, one infrequently used in research, in addition to the typical positive affect and negative affect scales.

METHOD

Participants

The participants in this study were 121 non-traditional undergraduate business students taking a junior level business course. Their average age was 30 (29.85 years), and they had an average of 9.8 years of work experience. Approximately 35% of the respondents were male. Both gender ratio and average age of respondents are very close to the gender ratio and age of the university student population.

Dependent Variables

Two dependent variables were examined. One was the frequency with which the non-traditional students felt different negative feelings and emotions as measured by Thompson's (2007 [33]) shortened PANAS scale for negative affect. The participants rated the terms, "upset", "hostile", "ashamed", "nervous", and "afraid" on a five point scale ranging from "1" for "very slightly or not at all" to "5" for "extremely". The reliability for the shortened negative affect scale was .83, as measured by Cronbach's alpha.

The second dependent variable was the "net affect", which was calculated by subtracting the negative affect scale from the positive affect scale. The reliability for the positive affect scale was .85, as measured by Cronbach's alpha.

Independent Variables

The independent variables were Gutek et al., 1991 [16], scales for measuring work interference with home and home interference with work, as well as development of additional scales to measure conflict with school, work, and family. For example, an original item measuring family-work conflict, "I'm often too tired at work because of things I have to do at home" was changed to "I'm often too tired at school because of things I have to do at home" to measure school - work conflict. This resulted in six scales of four items each. Participants rated each of the 24 items from "1" for "strongly agree" to "5" for "strongly disagree".

To determine scale reliability, Cronbach's Alpha was calculated for each scale. The reliability for each scale was as follows: work-family, .73; family-work, .72; work-school, .71, school - work, .69; family-school, .64; school-family, .75.

Analysis

Multiple regression analysis was used to identify the best "conflict" predictor of negative affect which students reported experiencing during the semester.

RESULTS

Using the shortened negative affect scale, two of the conflict scales were significantly related to the negative affect which students reported experiencing during the semester. Both scales reported conflict with family and both had negative coefficients significant at level of significance $\alpha=0.1$ (or 90% level of confidence). One indicated that school interfering with home, and the other reported family interfering with work. The multiple R for these two independent variables was 0.418, and the overall F-ratio was significant at $p<0.001$. When we added all of relevant independent variables in the regression analysis (both significant and insignificant ones) and added "age" and "gender dummy variables, the age and gender coefficients were not significant and the multiple R went up only to 0.429. The F-ratio remained significant at $p<0.01$. The significant independent variables remained the same at level of significance $\alpha=0.1$ (or 90% level of confidence).

Table 1: Regression analysis for the shortened version of Negative PANAS

6 case(s) deleted due to missing data.

Dep Var: SHPANASN N: 117 Multiple R: 0.418 Squared multiple R: 0.175

Adjusted squared multiple R: 0.161 Standard error of estimate: 4.344

| Effect | Coefficient | Std Error | Std Coef | Tolerance | t | P(2 Tail) |
|----------|-------------|-----------|----------|-----------|--------|-----------|
| CONSTANT | 18.974 | 1.795 | 0.000 | | 10.568 | 0.000 |
| SFCONFL | -0.210 | 0.109 | -0.176 | 0.875 | -1.931 | 0.056 |
| FWCONFL | -0.443 | 0.125 | -0.323 | 0.875 | -3.549 | 0.001 |

Analysis of Variance

| Source | Sum-of-Squares | df | Mean-Square | F-ratio | P |
|------------|----------------|-----|-------------|---------|-------|
| Regression | 456.318 | 2 | 228.159 | 12.093 | 0.000 |
| Residual | 2150.827 | 114 | 18.867 | | |

The second dependent variable was the net affect which was the result of subtracting negative affect scale score from the positive affect scale score. The same two scales found in the earlier analysis were significant predictors in the net affect regression analysis. The signs of coefficients, both become positive. However, the relationship between for these two was stronger than in the earlier analysis as measured by the standardize coefficients of the two conflict scales, and the multiple R was 0.521. The F-ratio was significant at $p < 0.001$. When we added all of relevant independent variables in the regression analysis (both significant and insignificant ones) and added “age” and “gender dummy variables, the gender coefficients was not significant but the age became significant and the multiple R went up only to 0.526. However, the introduction of age and gender and other independent variables has adversely affected the significance of the coefficient for the school family conflict (it is only significant at $\alpha = 0.125$) while the value of coefficient went up from 0.4 to 0.53. The F-ratio remained significant at $p < 0.001$. The coefficient for the other significant independent variable (family-work conflict) remained more or less the same (changed from 0.83 to 0.8).

Table 2: Regression analysis for the shortened version of net affect (negative PANAS - positive PANAS)

6 case(s) deleted due to missing data.

Dep Var: PANDIF N: 117 Multiple R: 0.521 Squared multiple R: 0.271

Adjusted squared multiple R: 0.258 Standard error of estimate: 6.178

| Effect | Coefficient | Std Error | Std Coef | Tolerance | t | P(2 Tail) |
|----------|-------------|-----------|----------|-----------|--------|-----------|
| CONSTANT | -9.077 | 2.554 | 0.000 | | -3.554 | 0.001 |
| SFCONFL | 0.397 | 0.155 | 0.219 | 0.87 | 2.564 | 0.012 |
| FWCONFL | 0.833 | 0.177 | 0.401 | 0.875 | 4.6 | 0.000 |

Analysis of Variance

| Source | Sum-of-Squares | df | Mean-Square | F-ratio | P |
|------------|----------------|-----|-------------|---------|-------|
| Regression | 1619.323 | 2 | 809.662 | 21.213 | 0.000 |
| Residual | 4351.258 | 114 | 38.169 | | |

DISCUSSION

In this section, we review the strengths and weaknesses of the study and suggest the possible routes for future studies. One weakness of the study is the small sample size. In future research, we plan to collect a larger sample which ensures a more reliable result. The R^2 is small which indicates that only a small percentage of the variations in dependent variable is explained with variations in independent variables. A second weakness is that the number of independent variables to examine variable interactions and effects of moderator variables on the relationship between affect and W-F-S conflict is lacking. On the other hand, one of the strengths of this study is that a study like this is one of handful number of studies which have examined more than just Work-Family and Family-Work conflict by introducing Study-Work, Work-Study, Family-Study, Study-Family conflicts. To the best of our knowledge, there are not many studies like this in the literature. Also, we have looked at non-traditional students, with an average age of 30 years old and almost 10 years of full time work experience, which is a good sample for studying the proposed conflicts. A second strength is the introduction of a composite measure of affect, one that examines “net affect”.

We believe that this study contributes to a better understanding of interrole conflict and affect. By investigating and additional interrole conflicts, school with work and family, we are extending the research in an area which demands additional attention, given the large number of non-traditional students in higher education today. Further, we utilized dependent variables, which have seen limited use in the study of interrole conflict.

There are several recommendations for future research. One, we encourage the use of Norlander, Johansson & Bood's (2005 [26]) typology of high and low PA and NA, where they identified the relationships of these typologies to experienced stress, sleep quality, optimism and energy. Two, studying how these interrole conflicts have an impact on health and performance at both work and at the university is worthy of examination. Three, investigation of the relationship between W-F-S conflict, affect, and academic turnover, i.e. withdrawal from courses and from degree programs is an area which has received little attention. Four, one might ask the question of how is financial need related to these conflicts and to experienced mood and affect. Is financial need an additional stressor or moderator of outcomes? Five, in addition to work performance, expansion of Cropanzo and James' (1993 [10]) research on affectivity as a predictor of work attitudes, such as organizational commitment, turnover intentions, job satisfaction, and Helweg-Larsen and Shepperd's (2001 [17]) research on the relationships of perceptions of risk and affect, as influenced by interrole conflict merits attention.

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DESIGNING AN INSTRUMENT TO MEASURE STUDENT SATISFACTION WITH A WEB BASED TRAINING AND TESTING TOOL

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ABSTRACT

With the rise of web-based learning services, various publishers offer web-based training and testing tools for providing interactive learning experiences and enhancing and supporting classroom teaching. Although one would agree that creating an engaging course and delivering a rich learning experience takes more than great software, web-based training and testing tools are an important component of learning in many higher education institutions. The purpose of this study is to design an instrument to examine the impact of a web-based training and testing tool on student learning from students' perspective.

INTRODUCTION

Higher education institutions across the globe face similar challenges such as building a better learning experience, improving learning processes and outcomes, and increasing student engagement. To address such concerns, and with the rise of web-based learning services, various publishers offer web-based training and testing tools for providing interactive learning experiences and enhancing and supporting classroom teaching. One such tool is known as SAM from Cengage Learning that can simulate Microsoft Office applications such as Excel and Access.

While most web-based training and testing tools help instructors engage in effective teaching practices, enhance and support classroom teaching, organize lessons, track student progress, and provide with instant and automatic grading, reporting and assessment tool, they are mainly designed to provide students with more engaging and interactive learning experiences. Although one would agree that creating an engaging course and delivering a rich learning experience takes more than great software, web-based training and testing tools are an important component of

learning in many higher education institutions. Thus, incorporating training and testing tools into a course may enhance and facilitate students' participation in active learning and reinforce course content.

The purpose of this study is to design an instrument to examine the impact of a web-based training and testing tool on student learning from students' perspective. A group of instructors at a private university in the North East incorporated the tool into an IT course called Problem Solving with Business Tools which is required for all freshmen regardless of their major. Because the instructors spend a great deal of class time teaching various problem solving skills and tools, and not enough class time challenging students with real-life business problems, the university decided to make use of the web-based tool. The expectation was that students can, on their own, understand features and functions of Excel and Access using the tool so that they can spend more time in class demonstrating their ability to use and apply their skills in support of business problem solving and decision-making.

LITERATURE REVIEW

Identifying the success factors behind the use of computer technologies in organizations has been an important goal of researchers. Some research frameworks such as the Information Systems Success Model [7] [8] focus on the relationship between user attitude, technology, information and net benefits to organization and individuals. Other frameworks such as the Technology Acceptance Model [6] [5] [10] specifically focus on user acceptance and satisfaction.

Information technologies have been incorporated into the learning domain in different e-learning forms and researchers have been trying to understand the effectiveness of information technologies in these forms. Enhanced classroom, blended learning, and fully online learning are three major forms of e-learning [15, p.97]. Technologies such as computers, computer networks, projectors, smart boards or handset systems are used to enhance classroom activities in an enhanced classroom form of e-learning [12]. Fully online learning such as massive open online courses (MOOCs) does not offer any in-class activities [28]. Blended learning represents a learning experience based on a combination of face-to-face learning and online learning. While this categorization of different types of e-learning is useful to distinguish different uses of technology in education, there are so many variations of e-learning forms and coming with a perfect categorization is a hard task. These forms are under constant change. For example, fully online learning systems advocates have been trying to incorporate the advantages of in class learning experience with new system features [2]. Our research is based on a blended learning course setting.

[31] defines four categories of blended learning: replacement, supplemental, emporium and buffet. In the replacement model, face-to-face class activities are replaced by online activities and class time is reduced. In the supplemental model, online resources are provided as a supplemental source without reducing the class time. Students heavily depend on the online lectures in the emporium model, but they can access a learning resource center to get help. In the buffet model, student can choose among face-to-face and online modules depending on their needs and preferences. Our research setting best fits the supplemental model among these

categories. In our research setting, class time was not reduced and instructors used the online resource as a supplemental tool.

In addition to the traditional information systems success research, the education context brought new dimensions related to the dynamics of learning such as learning methods or models. In their Adoptive Structuration Theory, [9] based their theoretical model on technology-mediated learning, [18] identified learning methods as part of the structural impact. [27] developed a framework for virtual learning environment effectiveness and included learning models as part of the design dimension. Design and human dimensions determine the effectiveness of the virtual learning environment in their study. [1, p.3] developed a conceptual productivity framework based on Information Success Model [7], the productivity concept [17], and the learning success theory [22].

Despite these research frameworks, [1] indicate that current technology-mediated learning research is not organized around a pivotal theoretical foundation. According to their literature review of 91 peer-reviewed research articles; 56 studies did not refer to a theoretical foundation and remaining 35 studies referred to a theoretical foundation 51 times. Only eight times Information Systems Success Model [7] or Technology Acceptance Model [5] was referred to as a theoretical foundation [1]. In their study based on Information Systems Success Model for e-learning systems, [14] report that system quality and information quality indirectly impact the system success, mainly through user satisfaction. In our study, we explore the effectiveness of the technology-mediated learning environment from an end-user satisfaction perspective [10] [11]. Major constructs of this study (content, accuracy, format, ease of use and timeliness) are also explored using the above mentioned frameworks.

Many introductory information systems courses focus on spreadsheet and database applications and simulation based training assessment tools are frequently used in all modes of e-learning. [24] indicate that these tools are also effective tools for measuring assurance of learning standards for accredited business schools. Literature on the role of simulation based training and assessment tools in technology-mediated learning frequently cite several tools such as “Skills Assessment Manager” (SAM) by Cengage Learning, SimNet (McGraw-Hill), and MyITLab (Pearson) [20]. One of the common themes in the literature is the use of these tools in student skill assessment in introductory information systems courses [29] to measure initial skills level of students and to determine exempt status of students for a given course [30]. Such initial assessment is important given the significant misperception of students about their spreadsheet skills at the beginning of such courses [16]. But these tools have more capabilities than the skill assessment need. They can simulate a lecture with verbal guidance, provide interactive training with behavioral modeling, offer individual trials without help, and grade the submitted work [19].

Researchers studied the effectiveness of these tools in different learning environments. For instance, having compared the traditional classroom environment with the blended learning environment; some research reported lower attrition rates, a lower failure rate, and higher student satisfaction in the blended environment than in the traditional environment [3], whereas some other research reported no significant difference between the traditional and the blended learning environment, in spite of slightly higher performance [21] or favorable student rating [25] in the

blended classrooms. Having compared the fully online form to the blended and the traditional classroom forms; one study [4] reports that blended and traditional forms are more effective than the fully online form. They further suggest that students are frustrated with the simulation's instruction and assessments and they are less likely to take another course in fully online form. Another study [27] reports some conflicting results that there is no significant difference between fully online and traditional classrooms in terms of performance, but students in the fully online form report higher computer self-efficiency. Parallel to the previous study, participants reported less satisfaction with the learning process in the fully online form.

RESEARCH METHODOLOGY

This study is based on data gathered through a survey taken by students at a small private university in the Northeast USA. The survey was posted on a virtual classroom used by the university and students had the right not to participate in the study. The university wanted to explore the impact of a web-based training and testing tool on student learning outcomes and measure student satisfaction level with the tool used in a required IT course.

In this study, student satisfaction with the training and testing tool was measured using a previously validated structured questionnaire adapted from [10], consisting of five subscales: content, accuracy, format, ease of use, and timeliness. After examining [10] instrument, we decided to revise the instrument and added two more measures of perceived overall satisfaction and reliability to the survey. We generated 24 items to measure students' perceptions. Some items were taken directly from the instrument without any changes; some were slightly modified to better reflect what was being measured. Some items in the questionnaire had to be reworded in reference to SAM, which is a training and testing tool used in this study. We finally designed the survey by grouping the 24 items into seven main constructs and used it to solicit students' perceptions of the tool content, accuracy, format, ease of use, timeliness, reliability and satisfaction. A five-point Likert-type scale was employed in the questionnaire where 1=strongly disagree and 5=strongly agree.

Students were informed that participation in this study was voluntary and the confidentiality of their identity in the survey would be maintained. The questionnaire asked students to rate the extent to which they agree with each statement by circling a number from one to five. Responses were obtained from 101 students enrolled in five sections of the same course.

Sample Characteristics

This study was conducted with a sample of 101 students enrolled in a required IT/MIS course at a private university located in the Northeast USA. Students were first asked to identify their gender. As seen in table 1, males make up 65.30 percent of the sample and females make up 34.70 percent. Students were then asked to indicate their major. It was reported that 14.85 percent majored in Accounting, 8.91 percent majored in Finance, 11.88 percent majored in General Business, 8.91 percent majored in Management and Leadership, 9.90 percent majored in Marketing/Marketing Comm., 16.83 percent majored in Sport Management, 14.85 had an Exploratory major, and finally 13.86 percent majored in various fields of studies (table 1).

Table 1: Sample respondents characteristics

| Item | Category | Frequency | Percent | Cumulative percent |
|--------|----------------------------|-----------|---------|--------------------|
| Gender | Male | 66 | 65.30 | 65.30 |
| | Female | 35 | 34.70 | 100.00 |
| Major | Accounting | 15 | 14.85 | 14.85 |
| | Finance | 9 | 8.91 | 23.76 |
| | General Business | 12 | 11.88 | 35.64 |
| | Management and Leadership | 9 | 8.91 | 44.55 |
| | Marketing /Marketing Comm. | 10 | 9.90 | 54.45 |
| | Sport Management | 17 | 16.83 | 71.28 |
| | Exploratory | 15 | 14.85 | 86.13 |
| | Other | 14 | 13.86 | 100.00 |

Data Analysis and Results

Because we added two new measures to the instrument developed by [10], we analyzed the data to examine the reliability and validity of the instrument.

The internal consistency reliability measure was calculated for the entire model as well as for each measure using Cronbach’s alpha coefficient. As pointed out by [26], internal consistency reliability is useful in the construction of a new instrument and measures the inconsistency of different questions intended to measure the same variable. Cronbach’s alpha values range from 0.89 to 0.94. All alpha values for all factors in each category are well above the recommended value of 0.7 [26].

The reliability values, means, and standard deviations are reported in table 2. As seen in table 2, item C2 in the content category, item A4 in the accuracy category, and item F4 in the format category, item E2 in the ease of use, item T2 in the timeliness category, item R1 in the reliability category, and item S1 in the satisfaction category attained the highest mean values.

| Item Code | Item Description | Mean | SD |
|--|--|------|------|
| Content (5) (reliability=0.94) | | | |
| C1 | SAM provides the precise information I need | 3.68 | 0.96 |
| C2 | The information content meets my needs. | 3.71 | 0.99 |
| C3 | SAM provides reports that seem to be just about what I need. | 3.54 | 1.13 |
| C4 | SAM provides sufficient information. | 3.65 | 0.99 |
| C5 | I find the output relevant. | 3.60 | 1.04 |
| Accuracy (4) (reliability=0.89) | | | |
| A1 | SAM data is accurate. | 3.54 | 1.02 |
| A2 | I feel the SAM main page output is reliable. | 3.77 | 0.90 |
| A3 | I find SAM is dependable. | 3.53 | 1.08 |

| | | | |
|----|--|------|------|
| A4 | I am satisfied with the availability of the SAM webpage. | 3.88 | 0.97 |
| | Format (4) (reliability= 0.89) | | |
| F1 | I think the SAM main page output is presented in a useful format. | 3.86 | 0.84 |
| F2 | The information displayed by the SAM main page is clear. | 3.88 | 0.88 |
| F3 | I am happy with the layout of the SAM main page. | 3.80 | 0.87 |
| F4 | The SAM main page output is easy to understand. | 3.90 | 0.90 |
| | Ease of Use (3) (reliability=0.90) | | |
| E1 | SAM is user friendly | 3.79 | 0.96 |
| E2 | SAM is easy to use. | 3.81 | 0.99 |
| E3 | Overall the SAM system is efficient. | 3.59 | 1.12 |
| | Timeliness (2) (reliability=0.91) | | |
| T1 | I get the information I need in time | 3.84 | 0.90 |
| T2 | SAM provides up-to-date information. | 3.86 | 0.86 |
| | Reliability (2) (reliability=0.92) | | |
| R1 | Overall, I am satisfied with the SAM system reliability | 3.56 | 1.10 |
| R2 | I am satisfied with the SAM system performance | 3.38 | 1.15 |
| | Satisfaction (4) (reliability=0.91) | | |
| S1 | Overall, I am satisfied with SAM. | 3.38 | 1.12 |
| S2 | Based on my experience with SAM, I'd buy SAM again. | 2.91 | 1.12 |
| S3 | Based on my experience with SAM, I'd recommend this product to a friend. | 3.04 | 1.10 |
| S4 | Considering the overall value of SAM I paid for, it was worth more than I paid for it. | 2.56 | 1.07 |
| | Entire Instrument (24) (reliability=0.97) | | |

A factor analysis was performed on the 24 items using principal components as the means of extraction and varimax as the method of rotation without specifying the number of factors. As seen in table 3, item C2 in the content category, item A2 in the accuracy category, and item F3 in the format category, item E1 in the ease of use category, items T1 and T2 in the timeliness category, items R1 and R2 in the reliability category, and item S3 in the satisfaction category attained the highest factor loading. All items in table 3 have large factor loadings on their corresponding factors, indicating that items in each category are a good measure of the corresponding construct. As suggested by [23], the larger the factor loadings, the stronger the evidence that the measured variable represents the underlying construct. Thus, the high loadings in table 3 can be interpreted as good construct validity for the 24 items of the instrument.

To make sure that the items in each category measured the same factor corrected item-to-total correlations were examined for each factor. Based on this analysis, items were to be eliminated if their corrected item total correlation was less than 0.50. As seen in table 3, no item was eliminated as their corrected item total correlation was greater than 0.50. This analysis is often performed to assess internal consistency.

Table 3: Factor loading, item reliability, and corrected-item-to-total correlation, reliability, and AVE

| Construct | Item Code (Variable) | Factor Loading | Item Reliability | Item-to-total correlation | Cronbach's α | Average Variance Extracted (AVE) |
|--------------|----------------------|----------------|------------------|---------------------------|---------------------|----------------------------------|
| Content | C1 | 0.900 | 0.811 | 0.813 | 0.94 | 0.813 |
| | C2 | 0.931 | 0.868 | 0.862 | | |
| | C3 | 0.894 | 0.799 | 0.796 | | |
| | C4 | 0.904 | 0.818 | 0.784 | | |
| | C5 | 0.878 | 0.771 | 0.783 | | |
| Accuracy | A1 | 0.831 | 0.690 | 0.680 | 0.89 | 0.773 |
| | A2 | 0.924 | 0.854 | 0.765 | | |
| | A3 | 0.872 | 0.761 | 0.815 | | |
| | A4 | 0.886 | 0.785 | 0.831 | | |
| Format | F1 | 0.927 | 0.859 | 0.760 | 0.95 | 0.873 |
| | F2 | 0.938 | 0.879 | 0.532 | | |
| | F3 | 0.947 | 0.897 | 0.732 | | |
| | F4 | 0.926 | 0.857 | 0.751 | | |
| Ease of Use | E1 | 0.936 | 0.875 | 0.776 | 0.90 | 0.852 |
| | E2 | 0.931 | 0.866 | 0.731 | | |
| | E3 | 0.902 | 0.814 | 0.842 | | |
| Timeliness | T1 | 0.959 | 0.919 | 0.779 | 0.91 | 0.919 |
| | T2 | 0.959 | 0.919 | 0.756 | | |
| Reliability | R1 | 0.964 | 0.929 | 0.850 | 0.92 | 0.929 |
| | R2 | 0.964 | 0.929 | 0.834 | | |
| Satisfaction | S1 | 0.892 | 0.796 | 0.845 | 0.91 | 0.796 |
| | S2 | 0.930 | 0.865 | 0.720 | | |
| | S3 | 0.958 | 0.918 | 0.791 | | |
| | S4 | 0.779 | 0.606 | 0.757 | | |

Convergent and Discriminant Validity

We also evaluated the instrument for convergent and discriminant validity. As suggested by [13], convergent validity can be assessed by the use of Average Variance Extracted (AVE), and item reliability. The AVE values range from 0.773 (Accuracy) to 0.929 (Reliability) and item reliabilities range from 0.606 (item S4) to 0.929 (items R1 and R2). As reported in table 3, the AVE value for each variable and item reliability for each item is greater than the cutoff value of 0.5 [13], indicating that the instrument demonstrates good convergent validity.

Table 4 shows the correlation matrix. Correlations between constructs range from 0.554 (Reliability-Format) to 0.832 (Reliability-Accuracy). Similarly, table 5 shows the squared correlations between constructs.

Table 4: Pair-wise construct correlations

| Variables | Content | Accuracy | Format | Ease of Use | Timeliness | Reliability | Satisfaction |
|--------------|---------|----------|--------|-------------|------------|-------------|--------------|
| Content | 1.000 | | | | | | |
| Accuracy | 0.788 | 1.000 | | | | | |
| Format | 0.789 | 0.779 | 1.000 | | | | |
| Ease of Use | 0.764 | 0.674 | 0.736 | 1.000 | | | |
| Timeliness | 0.751 | 0.799 | 0.807 | 0.676 | 1.000 | | |
| Reliability | 0.774 | 0.832 | 0.554 | 0.734 | 0.735 | 1.000 | |
| Satisfaction | 0.740 | 0.771 | 0.691 | 0.757 | 0.585 | 0.765 | 1.000 |

[13] suggests that discriminant validity can be demonstrated when the AVE value for each variable is greater than the corresponding squared correlation between two constructs. As seen in table 5, all of the squared correlations are smaller than the AVE values for each variable. Hence, the instrument used in this study exhibits evidence of discriminant validity.

Table 5: Squared correlations

| Variables | Content | Accuracy | Format | Ease of Use | Timeliness | Reliability | Satisfaction |
|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Content | 0.813 | | | | | | |
| Accuracy | 0.621 | 0.773 | | | | | |
| Format | 0.623 | 0.607 | 0.873 | | | | |
| Ease of Use | 0.584 | 0.454 | 0.542 | 0.852 | | | |
| Timeliness | 0.564 | 0.638 | 0.651 | 0.457 | 0.919 | | |
| Reliability | 0.599 | 0.692 | 0.307 | 0.539 | 0.540 | 0.929 | |
| Satisfaction | 0.548 | 0.594 | 0.477 | 0.573 | 0.342 | 0.585 | 0.796 |

Diagonal elements in table 5 are the average variance extracted for each variable/factor. Off-diagonal elements are the squared correlations between constructs. As seen, all average variance extracted values are greater than the corresponding squared correlations between the constructs. Thus, the instrument used in this study exhibits discriminant validity.

DISCUSSIONS AND CONCLUSIONS

A growing number of higher education institutions are implementing and incorporating a web-based training and testing tools into the curriculum to provide interactive learning experiences, increase student engagement, improve learning outcomes, facilitate students' participation in active learning, and reinforce course content. However, to be able to assess such benefits and use them for various student success initiatives, an instrument must be developed and validated through an experiential study/survey.

Since measuring learning outcomes and reporting evidence of learning necessitates the use of a reliable and valid instrument, in this experiential study, we redesigned a previously validated instrument by adding a couple of new constructs and made an attempt to revalidate it and provide additional evidence of its reliability. As outline in the data analysis section, we employed the instrument through an end-of semester survey, and were able to revalidate it. This study's results indicate that the instrument appears to be a reliable and valid instrument.

While this study focuses on redesigning a previously validated instrument and revalidating it through a survey, further research is needed to explore the unique contributions of such web-based training and testing tools in higher education and see if they provide students with the aforementioned benefits. Such tools may also be investigated to gather more detailed information about their value and see if they can be used across disciplines and degree programs.

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TEACHING STYLE – LEARNING STYLE FIT IMPLICATIONS FOR INTERNATIONAL JOINT DEGREE PROGRAMS

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ABSTRACT

The ever growing global economy has not only given rise to increased international trade and business partnerships, but also partnerships among institutions of higher learning through implementation of international joint degrees. These international degree program collaborations require cross-cultural exchanges among faculty and students. In addition, teaching style and learning style may differ across different cultures. Most of the recent studies examining both learning style and teaching style in international contexts were limited to comparative analysis along with little or no correlation or causal analysis. This study attempts to advance this research stream by examining the role in culture in determining what aspects of international joint degree programs are salient to faculty teaching style and student learning style.

INTRODUCTION

In today's complex and rapidly changing global economy, collective global prosperity is highly dependent upon political, economic, and social cooperation efforts that overcome local and international cultural barriers. In response to increased international travel and trade resulting from the current globalization era, higher education institutions around the world are experiencing increased motivations to develop and/or expand inter-institutional partnerships [10]. Joint- and dual-degree programs are the most typical approaches universities are using to advance the internationalization of their campuses and establish a global presence. These joint international degree programs have been established in various disciplines such as business, economics, engineering, international law, science, and medicine. Students enrolled in an international dual degree programs have an opportunity to receive a Bachelor's or Master's degree from two cooperating universities by studying at a local university and a partner university abroad.

International education partnership activities predominately fall into three categories, 1) short-term, 2) study abroad, and 3) joint/dual degree [3]. Short-term activities are often two to three week in length, offered during semester breaks, and the objective is to provide course-related cross-cultural exposure. Study abroad activities are usually semester long cross-cultural exchanges where home institution course credit can be acquired at an overseas partner institution. Joint/dual degree programs require an extended period of time abroad and offer the

opportunity for greater cross-cultural immersion. In joint degree program settings, students study at a local and international institution and ultimately receive a single degree issued by the participating institutions. Dual degree programs result in acquiring a separate degree from each of the participating institution. In all cases, development of global literacy or global awareness through cross-cultural exchange is the primary goal while experiencing international differences in academics is the secondary goal.

Benefits derived from the implementation of international joint degree programs can readily be ascertained [2] [3]. However, implementation of international joint degree programs certainly gives rise to potential challenges as well. Faculty and students benefit through the opportunity to acquire or enhance multicultural and global awareness, acquire new language ability, and experience international education. Participating institutions are provided with opportunity to engage in international staff research collaborations, advance global recognition and presence, and generate additional revenue from foreign student enrollment. Successful implementation of international joint degree programs warrant assurance of appropriate learning style preferences of international students so that teaching style strategies could be appropriately developed. In other words, international teacher and student exchange requires the understanding of cross-cultural social issues but cross-cultural teaching and learning issues.

Most of the recent research in the role of cultural differences in learning style has focused on explaining how cultural beliefs and behavioral patterns dictate learning style preferences (e.g., [7]). Most of the recent studies examining both learning style and teaching style in international contexts were limited to comparative analysis along with little or no correlation or causal analysis (e.g., [4] [12]). This study attempts to advance this research stream by examining the role in culture in determining what aspects of international joint degree programs are salient to faculty teaching style and student learning style. The specific research questions addressed are:

What aspects of culture impact student learning style?

What aspects of culture impact teaching style?

Is one learning style superior to another?

Is one teaching style superior to another?

THEORETICAL BACKGROUND

There is a growing body of evidence to suggest that a strong relationship exists between students' cultural backgrounds and their learning style preferences (e.g., [1] [11] [12]). Hofstede [9] noted that cross-cultural differences between the home country and the host country, including power distance, uncertainty avoidance, masculinity, individualism, and Confucian dynamic, should be seriously considered when examine multicultural learning contexts. Power distance refers to the extent to which less powerful members accept the fact that power is distributed unequally. In such situations, people obey the orders of their superiors that are regarded as having high power distance. In contrast, lower power distance based settings are characterized by decentralized decision-making and more equitable feelings of authority.

Uncertainty avoidance is the extent to which people feel threatened by ambiguous situations, and thus exert effort to try to avoid these. In contrast, willingness to take risks characterizes minimal uncertainty avoidance. Individualism represents the tendency to focus on the self and engage in individual initiatives. Conversely, low individualism or collectivism tends to favor strong identification with family and belonging to a group. Masculinity is a culture in which the dominant values in society are success, money, and possessions whereas low masculinity places greater importance on cooperation, a friendly atmosphere, and sense of security. The higher values of the Confucian dynamic represent values of thrift, persistence, loyalty and a future orientation, whereas the lower values of Confucian dynamic represents desire for person recognition and status in a social hierarchy.

Teaching and learning in an international joint degree setting clearly suggests that cross-cultural adjustment efforts by both faculty and students along with ensuring learning style – teaching style fit is essential to outcome success. This study will examine the role of power distance, uncertainty avoidance, individualism, masculinity, and Confucian dynamic in dictating preferred student learning style and faculty teaching style.

RESEARCH METHOD

Specifically, this study compares the teaching styles and students' preferred learning style of Chinese and American teachers and students respectively. Student learning style preferences will be assessed using the Felder & Silverman Index of Learning Style survey [5]. Faculty teaching style preference will be assessed using the Grasha Teaching Style survey [6]. Cultural orientation will be measured using item based on Hofstede's [8] [9] five cultural factors, or values, that are universal for a nation. These values include power distance, uncertainty avoidance, individualism, masculinity, and Confucian dynamic.

Chi square testing will be used to determine whether learning styles of the students as well as teaching style of faculty differ significantly according to their cultural background. Analysis of Covariance (ANCOVA) will be used to test teaching style – learning style main effects and interaction effects along with culture covariance.

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AN INVESTIGATION OF NURSE TECHNOLOGY TRAINING AND ACCEPTANCE OF EHR SOFTWARE

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ABSTRACT

There has been significant growth in implementing electronic health records (EHR) to provide physicians and nurses with access to accurate information about their patients at the time it is needed. Most EHR research has studied the physician adoption of EHRs and other e-Health technologies. Very little research has been conducted in how nursing training programs are preparing students to use these technologies in the field. This study investigates types of technologies that nursing programs teach; students perceptions of EHRs and their preparedness to use those systems; and how nursing training has affected nurses use of EHRs.

1. INTRODUCTION

More than 2.5 million nurses were recruited in the United States in 2008. Research shows that 17 percent of U.S. registered nurses deal regularly with electronic health records (EHRs) of patients [1]. A survey that was performed by the Office of Health IT Adoption showed that only 2 percent of hospitals and 4 percent of physician offices used electronic health records (EHRs) [2].

1.1 The Need For Electronic Health Records

President Obama urged converting medical paper records into electronic documentation because it would reduce administrative costs and medical errors[2]. Reduction in medical errors enables using electronic health (eHealth) information technologies (IT) affects in promoting quality, efficiency and safety of medical care by providing the correct information at the right time to treat patients and to make medical decisions based on accurate data [5] [12] [35]. Medication errors occur because nurses and physicians have insufficient information about their patients and the drugs, the illegibility of handwritten orders, and errors of calculation in drug dosage [3].

Studies have shown that in order to reduce medical errors, there are various types of technologies that include electronic communication of patient's data, computerized order entry by physicians, bar coding, and data support technology. Bates & Gawande [4] developed approaches to use information technologies for preventing errors by improving communication, making knowledge more accessible, requiring important parts of the information (such as dose of a drug), helping with calculations, monitoring assistance and helping in decision support. Healthcare workforce will be greatly affected by the transformation from paper records to EHRs as a tool to decrease medical errors and to enhance patient safety [2].

1.2 eHealth Technologies

Apart from investing in EHRs by U.S. government, there are several other eHealth technologies that have been integrated into clinical practice in order to enhance quality of healthcare [4]. Such eHealth technologies include picture archiving and communicating systems (PACs), electronic prescribing (ePrescribing), and computerized provider (or physician) order entry systems (CPOE) [5] [33] [53]. Some studies focused on how physicians and nurses manage various health technologies, such as computer-based nursing documentation, bar-code eMAR technology, CPOE, and electronic medical records (EMRs) in clinical practice [2] [26] [33] [50]. Researchers have also explored the experiences and attitudes of physicians and nursing staff and how they affected on accepting and using information technologies in the healthcare sector. These technologies include electronic patient records (EPRs), smart phones, telemedicine technology (eICU), smart IV pump technology, and telemonitoring systems [11] [21] [27] [37] [38] [49] [65].

Because nurses will be required to utilize a wide variety of technologies beyond those related directly to health care, a stream of research has evolved to examine nursing students' and medical students' attitudes, technical skills, and experience using information technology [17] [52] [56]. An important segment of this research involves how nursing students are trained in medical and related IT.

2. LITERATURE

There is a lack of attention given to informatics that are used by nurses, according to the first version of the U.S. health informatics agenda published by the Office of National Coordinator for Health Information Technology (ONC) in 2004[5]. The ONC's goal was only to mention medicine and tools that fulfill a physician's duty in delivering health care for their patients. However, research in the past showed that in the health care profession nurses obtain and retrieve most of the information in a patient's electronic record[5].

The authors [3] developed strategies to enhance patient safety by introducing an informatics-based approach to nursing education using a personal digital assistant (PDA) to obtain patient safety-related information and also to develop informatics competencies of nursing students. The authors suggested healthcare professionals must encounter requisite training in identifying the crucial part of information technology during basic educational programs, in order to project safe and efficient health care. In a nursing institute in Sweden, researchers found that students even had a lack in their basic IT skills, e.g. e-mail, word processing, and various databases on the World Wide Web, so they recommended the requisite to add IT competencies into nursing curriculum [52]. Teaching IT competencies in nursing courses is expected to build skills in health information technology literacy for the students. Sinclair & Gardner [54] commented that success in achieving IT competence on courses is going to develop nurses' confidence in using basic IT skills, and therefore enhancing the usage of more sophisticated IT systems in continuing nursing profession. Booth [6] stated that email and word processing proficiency are prerequisites for admission to most Canadian undergraduate nursing programs.

The authors [31] [43] [44] reported that the American Nurses Association (ANA) subdivided technology skills for beginning nurses, experienced nurses, and informatics nurse specialists. These two categories are computer literacy skills and information literacy skills. Computer literacy skills are comprised of using word processors, databases, spreadsheets, e-mail, and other information technology applications to record patient's data. Information literacy skills consist of the nurses' ability to run bibliographical retrievals, as well as obtain, and process information from the Internet. Dixon and Newlon [25] surveyed nursing students for evaluating different technology competencies experienced during their educational programs. Basic computer-based skills, such as basic desktop software and online learning were strongly identified by the

students, but information literacy skills, such as electronic documentation and monitoring were not represented in the students' discussions. However, researchers [22] found that there was a shortage in nursing students' informatics skills as only 12 percent of 325 students responded using electronic databases to seek information.

The authors [1] evaluated nurses' skills in using computers during their nursing practice and found that fifty-one percent of the nurses had experience using computers. Although the researchers did not ask nurses for a specific type of technology (e.g. telemonitoring, electronic documentation, etc.), the nurses showed significant positive attitude towards using computers during the survey [1] [7]. In a study about nursing students' attitudes, the students reacted positively to learning about technology, even though neither IT curriculum was offered nor did the students have option to explore IT application-related courses [42]. The author [42] found that the students were willing to learn in using PDAs and know about PDA software in order to assist them with patient care when they join their nursing practice. However, the study also found that there was a low exposure to IT education, even in graduate-level nursing schools [42]. Furthermore, during a recent survey, nursing students expressed their fear for professional risks of exposure to new technologies (e.g. Eco-graphs, computer tomography, etc.) that are implemented in current clinical practice [28].

The research in this particular area has shown that there are deficiencies in students' computer literacy skills (e.g. e-mail, word processing, Web-based search techniques, e-learning software) and suggested that IT skills be included in the nursing curriculum [22] [42] [52]. The International Medical Informatics Association (IMIA) has focused on designing and recommending courses related to health informatics (i.e. Health IT) (<http://www.imia.org/wg1>). Most of the research in this area has focused on surveying nursing students' perceptions toward technology to promote computer literacy skills in the nursing core curriculum [42] [44].

Due to this rapid growth in implementing EHRs in healthcare organizations [21], it is necessary to investigate the usefulness of EHRs as being experienced by nursing students after receiving formal education and training in EHRs from nursing educators, and the factors that influence

nursing students' perceptions to accept EHR later in their nursing careers. Critical to this is the implementation of curricula that teaches these types of skills.

3. PURPOSE OF STUDY

There is a shortage of research which examines nursing students' technology training, whether for general IT skills (word processing, email, database searches, etc.) or for other non-clinical technology such as EHRs. Recent research suggests the need to develop curriculum in nursing education for building technology skills of nursing students so that they can handle information technologies related to medical informatics [28]. Hence advanced computer literacy skills are crucial for nursing students to develop during their four-year baccalaureate program. Most of the recent research finds that nursing students remain proficient in basic computer literacy skills (e.g. E-mail, Word processing, Internet searches).

The purpose of this study is to investigate nursing students' technology training for general IT and EHR technology and whether their nursing school training affects their attitudes towards EHR technology in their careers. The goal of this study is to gather feedback from students about their attitudes towards using EHR technology. The purpose of training on EHRs is to build awareness and comfort in using EHRs to prepare the students to be confident with the technology before they use it in their careers. In order to investigate factors influencing nursing students' acceptance of an EHR in nursing education, the Technology Acceptance Model (TAM) [19] [20] conceptual framework can be used.

4. FRAMEWORK USING THE TECHNOLOGY ACCEPTANCE MODEL

In 1986, Davis first introduced the technology acceptance model (TAM), which is still used by many researchers to study about technology acceptance. TAM is established as a conceptual model to help understand intention to use a technology [47]. TAM provides a foundation to investigate how external variables affect belief, attitude, and intention to use a particular technology. The original TAM has five key determinants: perceived ease of use (PEOU), perceived usefulness (PU), attitude toward using (ATU), intention to use (ITU), and actual use (AU) of a computer system [19] [20] [38] [47]. When the authors [19] [20] introduced TAM, he hypothesized that perceived usefulness and perceived ease of use are to be core determinants of

user acceptance. During his research, he concluded that perceived usefulness as well as perceived ease of use was significantly correlated with current and predicted future use of technology (i.e. Electronic mail) [20]. Davis [20] suggested after his statistical analysis that perceived ease of use may actually be a causal antecedent to perceived usefulness (PU), as opposed to direct determinant of technology usage. Venkatesh and Davis [58] concentrated on understanding the antecedents of the perceived ease of use. They found out that general computer self-efficacy, one of the external variables plays as a determinant of perceived ease of use after participants receiving hands-on training on the technologies. The key determinants of technology acceptance are the indication that the computer system will help to improve job performance (i.e. PU) and the belief that the computer system requires only a minimal effort to use in the job, meaning the system is easy to use (i.e. PEOU). Figure 1 shows an overview of the original TAM [19] [20] [47].

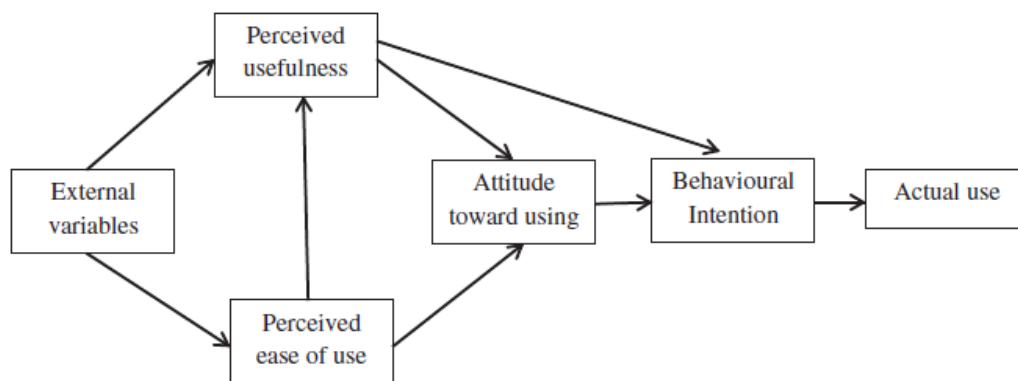


Figure 1: The Original Technology Acceptance Model [19, p. 985]

TAM has been used and updated over several years [32] [47]. TAM2 modified the original model, TAM to describe perceived usefulness and usage intentions that contain social influence (i.e. subjective norm, voluntariness, and image), cognitive instrumental processes (i.e. job relevance, output quality, and result demonstrability) and experience [59]. The extended model was verified in both voluntary and mandatory settings. The results significantly sustained TAM2 and clarified 60 percent of user adoption using this modified version of TAM [59].

PU and PEOU are considered in many research studies for evaluating attitudes toward using the computer system and eventually determining the ITU [20] [38] [58]. Park [47] explains that two

cognitive beliefs that are theorized by TAM: perceived usefulness and perceived ease of use. Based on TAM, the actual use of a technology system is affected directly or indirectly by the user's behavioral intentions, attitude, perceived usefulness of the system, and perceived ease of the system. TAM also suggests that external variables influence intention to use the technology and its actual use through mediated effects on perceived usefulness and perceived ease of use [20] [47].

Numerous researches studied TAM to investigate how nurses, physicians, and consumers (e.g. patients) accept use of various kinds of EHRs [34] [53] [61], mobile information technology [49] [66], telemedicine technology (eICU) [38], and telemonitoring system [27]. Liu & Ma [41] investigated extended TAM with web-based electronic medical record (EMR). They tested relationships between perceived system performance (PSP), perceived usefulness (PU), perceived ease of use (PEU), and intention to use EMR with healthcare trainees. PU can be defined as the extent to which a trainee believes using EMR will boost his or her job performance [60]. Meanwhile, PEU is defined as the extent to which one believes using EMR will be free of cognitive effort. During the survey, Liu & Ma [41] asked the trainees to perform primary EMR functions: (1) login to the system with provided account information; (2) create, update, and delete a patient record, search for a patient record, and add quick notes to a patient record; (3) search for a prescription, add and sign off a new prescription, and modify medications on a prescription; (4) upload and download a dictation audio file. They concluded that when the PSP is absent, TAM was validated as usual. However, when the PSP is present, the relationship between PEU and acceptance of technology became insignificant [41].

4.1 TAM in Healthcare Technology Research

Many studies in information technologies indicated that key factors affecting nurses' attitudes toward using computers are age, years of working in hospitals, education level, and years of experience working with computers [10] [14] [21] [38]. The TAM provides the related constructs of PU, PEOU, and BI. PU and PEOU are primary key determinants of technology acceptance behaviors [20]. Both determinants affect attitudes, leading to BI and lastly to actual usage of the technology [20] [38]. During testing of TAM by De Veer & Francke [21], nurses' positive attitudes toward using electronic patient records (EPR) were primarily associated with user-

characteristics (i.e. Education level, years of job experience, hours employed) and PU, with respect to quality of care. In addition, subjective norm/social influence (i.e. Expressing the influence of colleagues, supervisors, and patients) acted a positive significance on influencing PU in adoption of mobile information technology (e.g. PDAs) [66].

Park & Chen [49] hypothesized that behavioral intention to use smartphone by doctors and nurses is mostly determined by attitude toward using a smartphone, perceived usefulness, and self-efficacy. Their findings indicated that self-efficacy had a significant influence on both perceived ease of usefulness and intention to use. This result interprets that the physicians show a higher perception of ease of use if they have prior experience and feel confident in their basic computing skills [49].

The authors [39] examined the applicability of extended TAM with self-efficacy in nursing educational setting, students' self-efficacy was found to be a significant factor for perceived ease of use and usefulness. They investigated factors influencing the nursing students' acceptance of electronic health records for nursing education (EHRNE). Their results indicated that the students who have higher EHRNE self-efficacy were more likely to believe that the system is easy to use. This led them to believe that the EHRNE system will enhance their learning outcomes (perceived usefulness) [39]. Previous studies used TAM as a theoretical framework to explore the students' acceptance of technology in educational settings, such as web-based learning, online courses, and clinical imaging portal for developing healthcare education [14] [16] [57]. All the researchers explored factors affecting intentions to use technologies based on TAM, along with the computer self-efficacy as being an external variable. Structural equation modeling (SEM) showed that attitude toward using the technologies resulted a significant effect on behavioral intention to use, perceived ease of use, and computer self-efficacy [16] [57]. SEM was used to test the hypothesis and demonstrate the effects among different variables of TAM and goodness-of-fit of the model [39].

TAM has developed over time, being also used for studying various technology systems with different sets of populations (e.g. Doctors, nurses, and consumers/patients). The structure of TAM and its constructs were extensively used in health information technology (e.g. EHRs,

personal digital assistants- PDAs, etc.), nursing and medical education for evaluating attitudes toward using particular computer technologies [10] [21] [27] [37]. However, there have been few studies that explore experiences and attitudes of healthcare professionals using various technologies in healthcare practice [34] [53] [61] [63], and even less with regard to nursing students experiencing health information technologies in their nursing education [16] [39]. TAM will be used in this study to examine nursing students' technology training and how it affects nursing students' intentions to use electronic-records system by exploring the various factors that influence perceived ease of use and perceived usefulness of the electronic system.

5. PROPOSED CONCEPTUAL FRAMEWORK

For the current study, TAM will be utilized along with constructs of self-efficacy with general computer skills, social influence, training on EHR technology, perceived voluntariness of EHR systems in their nursing careers to study nursing students' technology training and how it affects their intentions to use EHRs. The perceived usefulness of EHRs, perceived ease of use of EHRs, and behavioral intention to use EHRs in their careers will be examined for the TAM constructs. The proposed TAM constructs and definitions are in Table 1 and the diagram is in Figure 2.

Table 1: Constructs of Proposed TAM and Definitions

| Constructs | Definitions (Nursing Student Context) |
|--|--|
| Computer Self-Efficacy [57] [60] | A student's judgment of his or her own capability to use a computer. (Based on history of general computer use) |
| Social Influence [59] [60] | "the degree to which an individual perceives that important others believe he or she should know the new system" [60, p. 451] (Based on perceptions of other students and faculty members) |
| Training | The degree to which educators train practical skills and deliver knowledge related with developing a person's specific competence. (Based on classes in nursing training, the depth, quantity, and quality of the training, and the attitude of educators towards EHR software) |
| Voluntariness [59] | "the degree to which potential adopters perceive the adoption decision to be non-mandatory" [59, p. 188] in their future job positions. |
| Perceived Usefulness [20] [60] | "the degree to which a person believes that using a particular system would enhance his or her job performance" [20, p. 320] [60, pp. 428 & 448] (Based on his or her perceptions of future use on the job) |
| Perceived Ease of Use [20] [60] | "the degree to which a person believes that using a system would be free of effort" [20, p. 320] [60, pp. 428 & 451] (Based on his or her perception of EHR ease of use) |
| Behavioral Intention to Use [40] [65] | "Behavioral intention is an individual's subjective probability of performing a specified behavior. " [40, p. 103] |

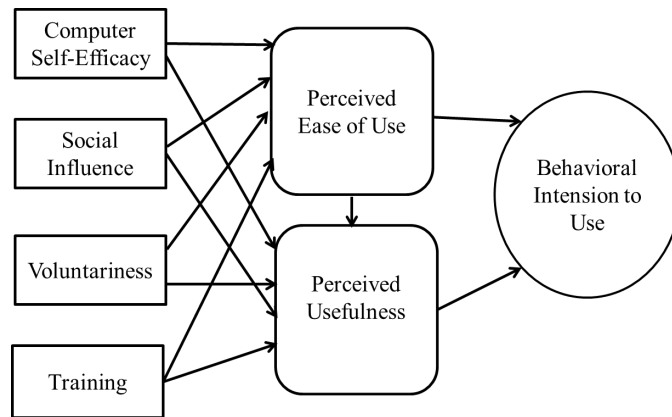


Figure 2: Proposed TAM Diagram

5.1 Research Hypotheses

Our hypotheses are based on examining the relationships between external variables (i.e. Computer self-efficacy, social influence, technical support, training, experiences in using other information technologies), key determinants of original TAM, and intention to use the EHRs. Below are the proposed hypotheses and the diagram with the hypotheses is shown in Figure 3.

Self-Efficacy:

H1a. Computer self-efficacy of nursing students positively affects perceived usefulness of electronic-records system.

H1b. Computer self-efficacy of nursing students positively affects perceived ease of use of electronic-records system.

Social Influence:

H2a. Social influence positively affects perceived usefulness of electronic-records system.

H2b. Social influence positively affects perception of electronic-records system's ease of use.

Training:

H3a. Training attained by nursing students positively affects perceived usefulness of electronic-records system.

H3b. Training achieved by nursing students positively affects perception of electronic-records system's ease of use.

Voluntariness:

H4a. Voluntariness of nursing students positively affects perceived usefulness of electronic-records system.

H4b. Voluntariness of nursing students positively affects electronic-records system's ease of use.

Ease of Use:

H5a. Nursing students' perception of electronic-records system's ease of use positively affects students' intention to use electronic-records system.

H5b. Nursing students' perception of electronic-records system's ease of use positively affects perceived usefulness of electronic-records system.

Usefulness:

H6. Nursing students' perceived usefulness of electronic-records system positively affects students' intentions to use the electronic-records system.

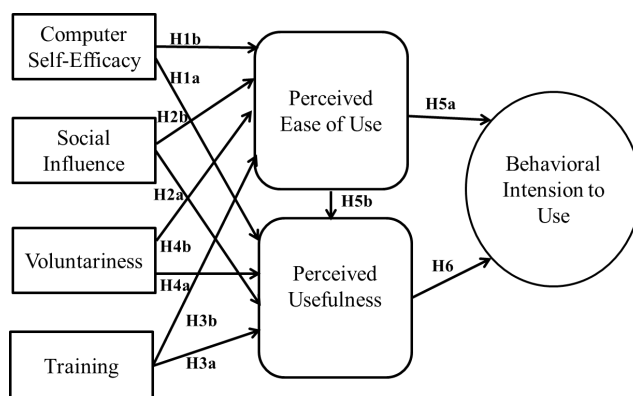


Figure 3: Proposed TAM Diagram with Hypotheses

6. METHODOLOGY, DATA COLLECTION, AND ANALYSIS

This stream of research is going to be conducted in three phases. The first phase is investigational in nature to discover what types of technologies were taught in nursing programs. In the first phase, a thorough examination of existing literature was conducted to learn more about the different technologies being studied in health care. After compiling the list, they were categorized into types of technologies. Based on this list, nursing program directors in the state university system were asked what technologies they teach.

The second phase was the creation of hypotheses based on information gathered from the first phase. These hypotheses will be the basis of survey questions which will be administered to students currently in nursing programs in the University of North Carolina (UNC) system to see if the constructs of Computer Self-Efficacy, Social Influence, Voluntariness, and Training positively affect Perceived Ease of Use, Perceived Usefulness, and Behavioral Intention to Use. Nursing students will be asked to participate in the survey. These students are currently enrolled in state nursing schools that offer a four-year baccalaureate program and approve by the state Board of Nursing (<http://www.ncbon.com>). Questions will be organized into different domains (e.g., Computer self-efficacy, social influence, training, voluntariness, etc.), based on different categories of constructs that are proposed in our model. The response for each question will consist of the Likert-type 1-5 rating scale, with a higher score indicating a positive intention to use the electronic health record system. Structural Equation Modeling (SEM) will be used to analyze the constructs in the model.

The third phase will investigate the same constructs in addition to a construct for Experience based on a survey administered to nurses who are currently working in a clinical setting. Nurses who work in local hospitals and physicians' offices will be asked to participate in the survey. SEM will be used to analyze the constructs in the model.

7. PRELIMINARY FINDINGS

One of our contributions is to accumulate and categorize a list of updated information technologies and computer-based technologies studied in previous research. In our research, an extensive review of general (e.g. Email, word-processing, spreadsheet, internet, etc.) and medical information technologies (e.g. Electronic medical records, CPOE, PDA, etc.) was performed to find whether these implemented technologies in healthcare profession are matched with the technologies that are currently introduced to students in nursing schools. While searching for information technologies (i.e., general and medical) in research articles, more than half of the articles studied about electronic health records (EHR) or electronic medical records (EMR) that are implemented in clinical practice. The following table of our literature sources shows that there is a lack of research studies performed regarding perceptions of nursing students who are currently adopting electronic-records system in their nursing education.

Table 2: List of General and Medical Technologies Used by Nursing Students

| Technology | Source | Sample |
|--|--------|--|
| Electronic health records (EHR); | [39] | Undergraduate nursing students |
| | [8] | Healthcare providers (i.e. nurses, medical residents, medical faculty) |
| Electronic Patient Records (EPRs); | [21] | Nursing staff members |
| Electronic Medical Records (EMRs); | [18] | Senior physicians, junior doctor, nurses |
| Word processing; Spreadsheet applications; | [44] | Nursing program administrators, directors, managers, deans, and educators |
| Email; Internet; | [42] | Nursing students |
| | [31] | Nurses |
| | [54] | Nursing students |
| | [22] | Nursing students |
| | [52] | Nursing students and nursing educators |
| | [30] | Hospital clinical staff members - medical and dental, nursing, and allied health professionals |
| Wireless Personal Digital Assistant (PDA); | [3] | Undergraduate and graduate nursing students |
| | [66] | Nurses |
| Mobile Information Technology- | [63] | Physicians, nurses, medical technicians |
| SmartPhone; | [49] | Nurses and doctors |
| Telemedicine Technology (eICU); | [38] | Nurses |
| | [46] | Nurses |
| Computerized Physician Order Entry (CPOE); | [11] | Nurses |
| Bar-Coded Medication Administration Technology (BCMA); | [33] | Nurses |
| Computer-based Nursing Documentation; | [2] | Nurses |
| Computerized Clinical Documentation; | [55] | Nurses |
| Clinical Imaging Portal; | [16] | Nursing students |
| Smart IV Pump Technology; | [11] | Nurses |
| Telemonitoring; | [13] | Physicians and nurses |

In order to get the most recent update of information technologies (IT) that are now offered to students by nursing faculties, we emailed a set of survey questions to 12 nursing schools, approved by the NC Board of Nursing in North Carolina. We received four responses after sending the questions to the high-ranked faculty members (e.g. Directors, associate deans, program coordinators, etc.). Most of our questions were related to students' general IT skills and medical IT skills whether they were offered in their nursing curriculum in the form of taking courses related to informatics or hands-on training of IT applications (e.g. Electronic health-records system) during their nursing education. Most of our survey questions focus on asking whether the specific general and medical technologies were introduced to students in undergraduate programs. We have provided a summary of responses in Table 3.

Table 3: Responses for Nursing Curricula Related to Information Technology

| Questions | Response from Faculty-1 | Response from Faculty-2 | Response from Faculty-3 | Response from Faculty-4 |
|--|--|---|--|--|
| Courses related with information technologies (IT)- general or medical | No specific IT courses are offered in undergraduate program. | Courses in gaining general IT skills are offered in undergraduate program. No medical IT courses are offered. | Courses in gaining medical IT are taught in undergraduate program. | A basic computer course is required in undergraduate program. No medical IT courses are offered within College of Nursing. |
| General IT skills taught or trained or used in classes | Internet searches; Access online library resources trained through orientations from librarians; | Online learning platforms; Internet search engines; Online journals; | Blackboard Learning Management System; Electronic library searches; | Few general IT skills are used in the basic computer course. |
| Software taught or trained to apply general IT skills | Students and faculty members communicate via email. | Word Processing; Excel; PowerPoint presentation software; | Word Processing; PowerPoint presentation software- Prezi; | Word Processing; Excel; PowerPoint; |
| Medical IT skills taught or trained | Students are required to receive training on E.H.R. | Students receive hands-on training in medical skills: managing infusions & manage output for assessment; monitoring blood oxygenation & closed pressure system; | E.H.R. is used in all clinical nursing courses; Technical equipments such as cardiac monitoring, fetal monitoring, & infusion pumps are trained to gain medical IT skills; | Students learn to document patients' records in EMR. |
| Specific software package taught or trained to gain medical IT skills | EpiCare software application: Web-based software technology for E.H.R. | Electronic database- Medline & CIHAL; EpiCare software application; | Not specified. | Not specified. |
| Number of months/years trained to attain hands-on experience in medical IT | Students experience 4-year hands-on training session in EpiCare software | Not specified. | Not specified. | Not specified. |

Responses from our survey show that there are no specific courses offered for learning health information technology. Within the existing curriculum, nursing educators not only train their students to be proficient in computer literacy skills, but also currently train them to use local EHRs (e.g. EpiCare software application). Most of the responses from our survey questionnaire showed that implementation of an application for electronic documentation has now become widespread in training students among nursing schools in North Carolina, but no research articles in literature review focus on students developing their skills in advanced information technologies (e.g. EpiCare, Medline, etc.). Its application is a Web-based application that permits physicians and patients to view laboratory tests, request an appointment and prescription renewals after reviewing the list of patients' allergies, medications, and health care issues. In past studies, research in experiencing and using electronic record's application has been done from patients' and physicians' perspective.

8. FUTURE WORK

Currently, our paper is on a research-in-progress study. After we collected responses regarding updated general and medical IT skills from various nursing schools in North Carolina in phase I, we will develop questionnaires based on the information provided by the nursing schools for phase II. Questionnaires will be sent to nursing students in these nursing schools as part of this phase. As these nursing schools fall under the UNC system, we consider the students of these schools as our convenient sample. Further studies in more diverse settings will need to be done. Additionally, in phase III, questionnaires will be customized and sent to nurses who are working in a clinical setting.

9. CONCLUSION AND FUTURE WORK

In order to explore the nursing students' intention to use the electronic-records system, exploring perceived ease of use and perceived usefulness of the system is necessary. In nursing care, patients' outcomes are the most prior concern. Nursing students must be provided with educational opportunities in their nursing schools in order to adapt to updated technology. As a result, these new entry-level nurses could devote their full concentration in their new surroundings of patient care, instead of taking out extra time in educating themselves for working with new technologies (e.g. Electronic records system) during their nursing practice.

Furthermore, our study in technology acceptance by nursing students will extend the TAM conceptual model and other constructs that have been developed for the area of social psychology [20] [38]. Previous studies [11] [38] that used an extended version of TAM, successfully predicted nurses' as well as physicians' intentions to use technologies in the healthcare sector. Their study showed that their proposed models had applied in explaining and predicting behavioral intention to use the technology in both clinical and nursing practices. Previous research studies on intrinsic motivation and self-efficacy in social psychology show that enjoyment, goal orientation, and self-efficacy play vital roles in determining a person's behavior [65]. Past research on technology acceptance behavior assessed the effects of self-efficacy and enjoyment of perceived ease of use [59] [64]. The proposed TAM model will provide more insight about nursing students' and nurses' intentions to use electronic-records systems.

After determining the factors that are going to influence students' intentions to use electronic-records system during their nursing education, we anticipate to explore registered nurses' perception in the system's actual use in the clinical practice setting. We expect to observe professional nurses' positive attitude in using the electronic system, after attaining EHR skills as well as experiencing perceived usefulness of the electronic system during their nursing education. Therefore, for our future contribution to obtain factors influencing registered nurses' perceptions, we will propose a similar version of the proposed TAM model that would relate constructs (e.g. past experience of information technologies; the education level of nurses; social influences of other nurses, physicians, administrators, experience and training with electronic health records, etc.) of registered nurses working in clinical setting.

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Mission Impossible? Better Conference Presentations

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ABSTRACT:

Over the last 45 years, conference presentation formats have remained basically the same, mini-papers. Overhead transparencies were just replaced with PowerPoint slides with copied/pasted content from the papers. Why has the format not changed? The argument is - “that is the way presentations have always been done and no one will respect the research if the research results are not presented that way”. However, attendees often complain that sessions are boring with too many words, too many figures, and more importantly many times the presenters run out of time before getting to their results. This session will explore current professional trends and tools for more engaging presentations.

Better Conference Presentations:

What is the purpose of conference presentations? Most would agree that it is to report on submitted papers in order to share research or innovations, to receive constructive feedback from attendees, and to build Vitas. Plus session presentations are generally required in order to obtain travel money. But the current “tried and true” model sets up "Death by PowerPoint," not audience engagement. Why? Because so many presentations are basically data dumps.

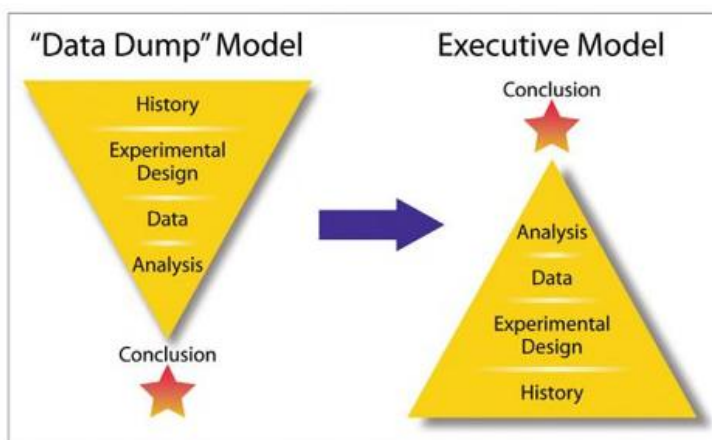


Figure 12.2 Data Dump vs. Executive Model

Speaking Up: Surviving Executive Presentations By Frederick Gilbert p.105

Slides are just text and charts copied right out of papers and pasted on to the slides. The depth needed for a paper does not automatically transfer into effective

presentations. The presenter understands the research but the attendees cannot assimilate overwhelming data unless it is simplified and effectively presented.

Presentations shouldn't be mini-papers. Conference attendees can read papers in the proceedings or request copies from the presenter if they want details. They are attending sessions to learn and hopefully be engaged to a level of being able to provide helpful feedback to the presenter.

Presentations in the business world are evolving along with technology but why is there such resistance to changes within the research conference world? Is "because that is the way they have always been done," an adequate reason for not staying current in presentation trends? Sticking with methods that are becoming antiquated means that faculty are not being good role models for students who will be seeking employment in up-to-date business environments.

This session will look at current business/professional presentations trends and new capabilities of presentation software. The goal is to explore how to use these new trends and technologies to make conference presentations more engaging and effective and to encourage presenters to step outside of their comfort zone to try new formats. Hopefully change won't be an impossible mission.

Office Mix – SuperPowers for PowerPoint

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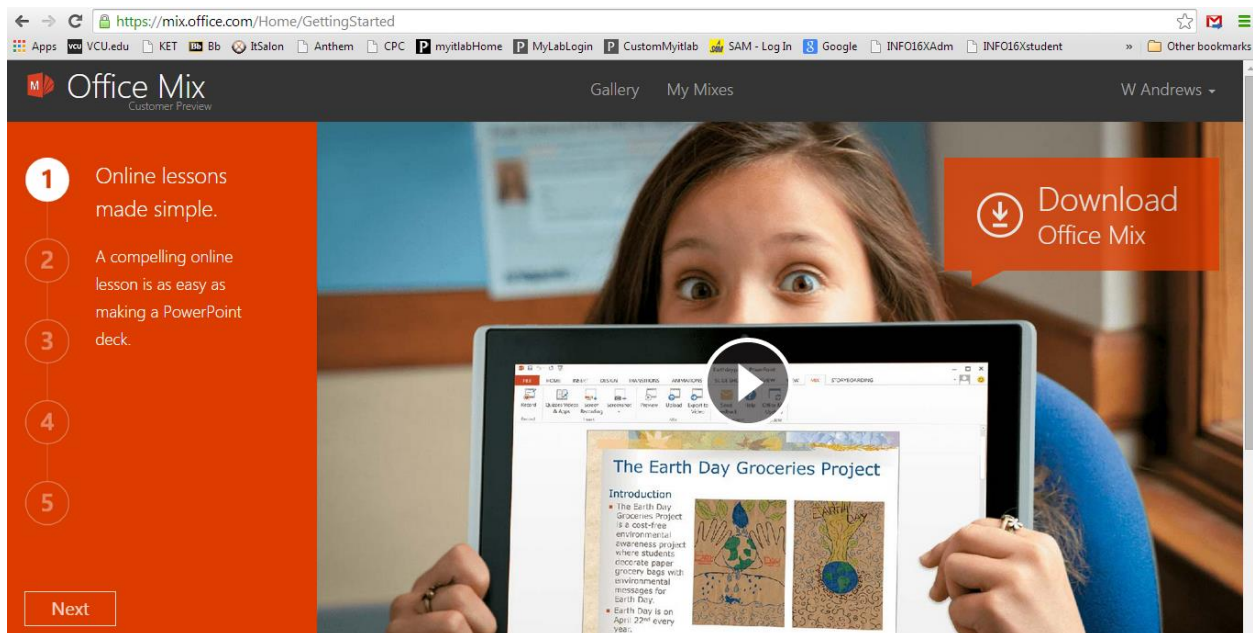
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ABSTRACT:

Interactive presentations are a hot topic in the presentation arena. There are many products available to use that produce interactive presentation features but many are expensive and have a steep learning curve. Microsoft's Office Mix is a new player in this area. Features of and experiences with Office Mix will be shared in this session.

Office Mix

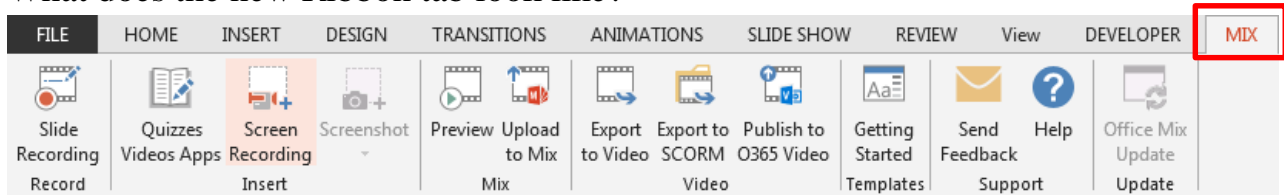
Microsoft has a new PowerPoint Add-on called **Office Mix** that is free and easy to download, but is currently only available for use with Office 2013 or Office 365 on PCs. Office Mix has the potential to change how educators and professionals will use PowerPoint.



The screenshot shows the Office Mix website interface. The browser address bar displays <https://mix.office.com/Home/GettingStarted>. The page features a navigation bar with 'Office Mix Customer Preview', 'Gallery', 'My Mixes', and a user profile 'W Andrews'. A vertical list of five numbered steps is on the left, with the first step highlighted: '1 Online lessons made simple.' Below the list is a 'Next' button. The main content area shows a woman holding a tablet. The tablet screen displays a PowerPoint slide titled 'The Earth Day Groceries Project' with an 'Introduction' section and two images of children's drawings. A play button icon is overlaid on the tablet screen. In the top right corner of the page, there is a 'Download Office Mix' button with a download icon.

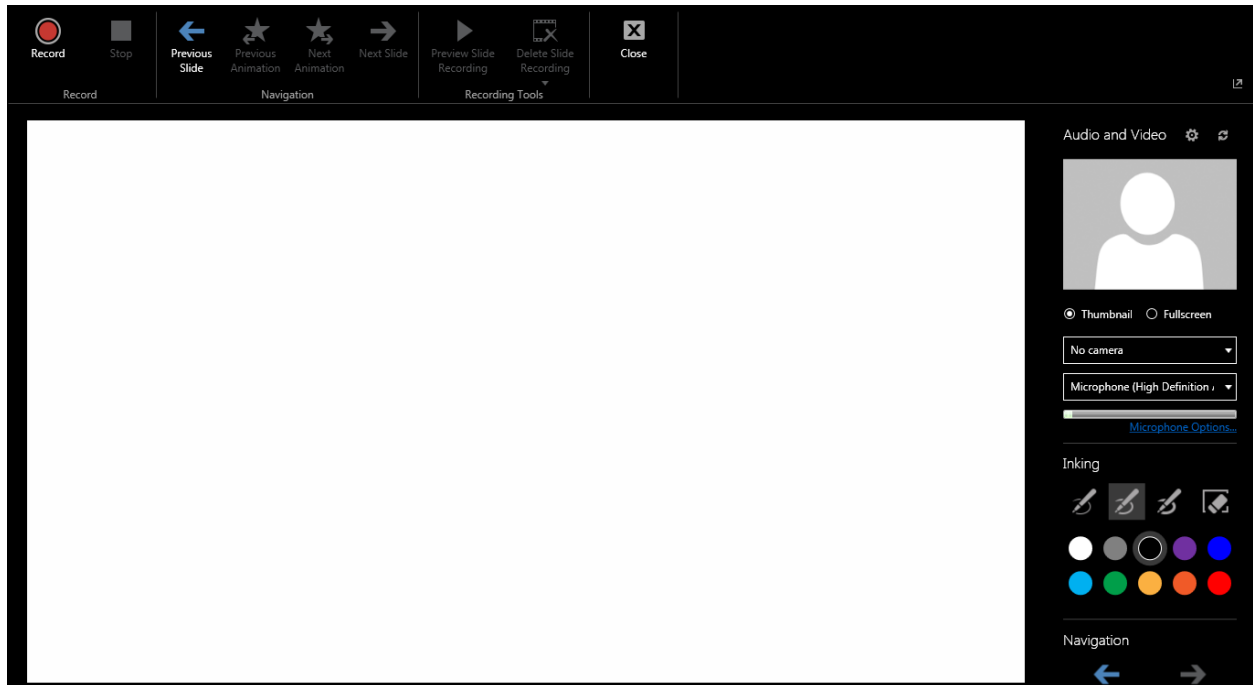
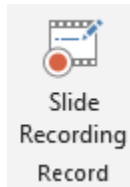
In the download a PowerPoint training template file is included that steps users through the new features. The possibilities are exciting for in-class and supplemental instruction use as well as incorporating Mixes for online training and online courses. Each slide can basically become a multimedia collection of whatever the Mix creator wants to put on it.

What does the new Ribbon tab look like?

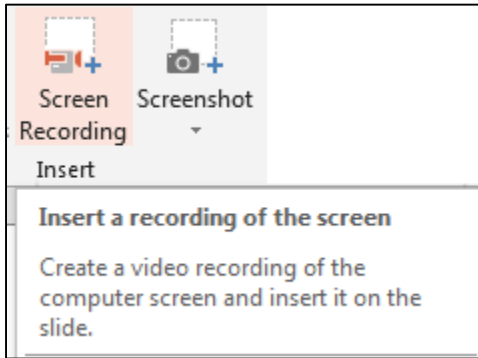


It includes access to audio and video recordings using any PC. Interactive quizzes can be generated using free apps, screen captures can be included and “live” websites added.

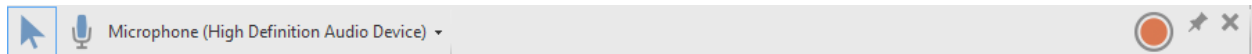
With slide recording, you can record your voice, include (or not) your image as you are recording, and annotate the slides.



Screen Recording allows recording of websites or other open applications with mouse actions and voice recorded.

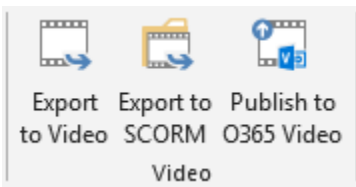


Click on Screen Recording and the most recently opened window, such as Excel or an application software, will appear. Use the selection tool to select the area you to be included and then click on the record button, top of the screen. When finished, click on the red square to stop recording.

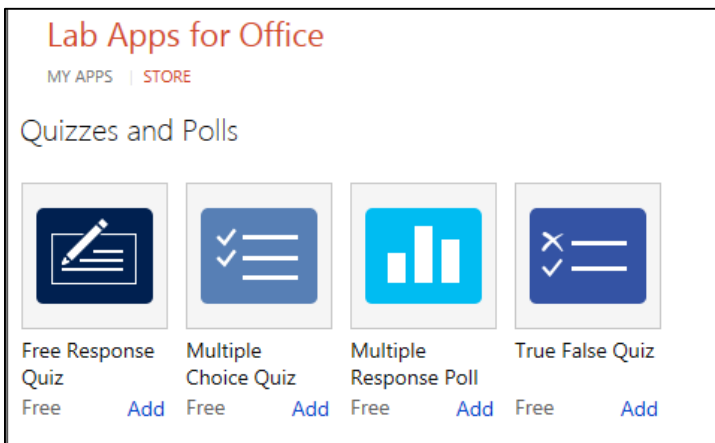


Screenshot command shows the most recently opened window and an area can be selected but only a “picture” is taken, hence there is no interactivity.

Video options include exporting to video, which will not include any interactive elements like quizzes; export to SCORM, which is a standard for e-Learning interoperability; and export to Office 365 video portal.



Several types of free quizzing features are available and can be used in the

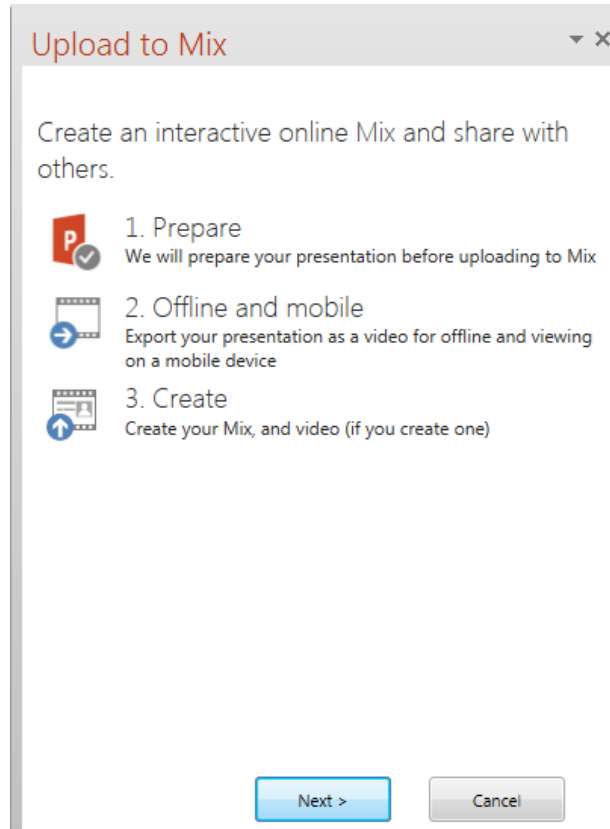
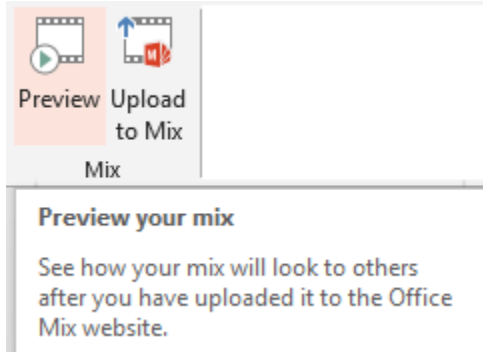


classroom to poll or quiz students with any device that has the capability of connecting to the Internet. Some of the free apps have number and functionality limits.

Responses can be downloaded for grading and statistical

summaries from the quizzes can be generated.

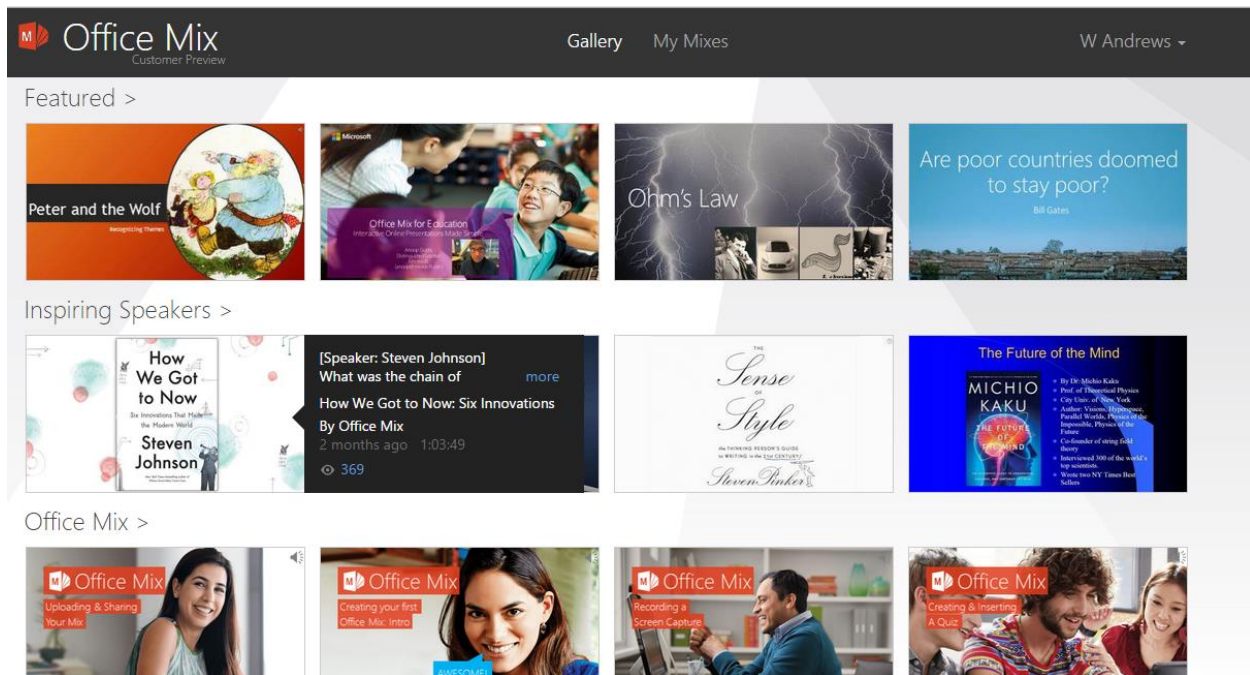
Once the file is created there is a preview feature that allows viewing prior to making it available to others. When the file is ready it can then be uploaded to Office Mix at OneDrive using a Microsoft account. The file is converted to an HTML5 video file.



Office Mixes are posted on the Cloud and can be either private or shared. If shared, links are generated that can be e-mailed or posted at a Learning Management System or webpage. The Mixes are available for video off line on any device via One Drive.

There are search capabilities at mix.office.com by content and tags for shared mixes.

<https://mix.office.com/Gallery>



In summary, the Microsoft's Office Team blogged:

"Office Mix adds functionality to PowerPoint 2013 that allows you to record audio or video of yourself presenting, write on your slides as you speak to them, insert quizzes, polls, online videos, and more. In fact, you can even do full screen capture and record anything on your PC."

<http://elearninfo247.com/2014/11/17/product-review-microsoft-office-mix-add-in-for-powerpoint-2013/>

**e-Portfolios:
A Vehicle to Improve the Marketability of Information Systems Graduates
and
Come Full-Circle in Curriculum Assessment:**

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Abstract:

Using self-managed student e-Portfolios to collect and assess indirect measures for student and program learning objectives has been made easier and attainable through professional social media networks such as LinkedIn and Google Sites. This paper chronicles the progress of Virginia Commonwealth University's Department of Information Systems initiative to improve the marketing of its graduates and build a network of alumni to improve program assessment. A rationale and process model is presented for implanting a self-managed and non-academic hosting solution using student ePortfolios as the content vehicle for coming full circle for curriculum assessment.

Background:

University faculty advisors have long been challenged in recommending ways in which soon-to-be graduates can best represent themselves to potential employers. Michael Porter would advise them to use information technology to provide a competitive advantage in the job market. Constructing resumes that list academic achievements and technical skill sets are the traditional recommendations, coupled with any personal employer contacts that have been cultivated over the years. Yes, there is Monster.com which provides a massive field of opportunities for new graduates, but the market has the advantage of identifying well-qualified and experienced information systems (IS) professionals. The resumes from veteran IS professionals include proven track records including references to specific IS skills, knowledge, and real-world experience. Established professional associations such as the Association of Information Technology Professionals or the Project Management Institute provide social and professional networks for members to advance their careers. New graduates are at a disadvantage in this marketplace; they do not have the extensive professional experiences to draw upon for differentiating themselves.

Faced with the challenge of developing a strategy that can assist new IS graduates in securing employment in their chosen field of study, the Information Systems Department at Virginia Commonwealth University recommended that a process leading to student ePortfolios for all IS majors would allow the new graduates an opportunity to have their qualifications experience a more comprehensive assessment by potential employers, increasing their chances for in-person interviews. dPortfolios use the time-honored technique used by those in fine arts, teaching, architecture, and engineering who create portfolios that include artifacts which represent their best work achievements.

IS students could collect and organize hardcopy artifacts that demonstrate their understanding of IS techniques and evidence technical skill sets. However, this approach in itself does not exhibit a basic tenet that graduates in information systems would be expected to demonstrate, the use of information technology in presenting the collection of artifacts that describe their academic achievements and learned technology skill sets. Use the IS tools and techniques learned in completing their curriculum program to create an ePortfolio is the natural solution to pursue. Members of the advisory board have been supportive of the Information Systems Departments initiative to provide IS graduates a more competitive advantage in securing a job. The first step in implementing this initiative was to develop a process for implementation, a set of guidelines for students to use in creating their ePortfolio, examples that exhibit various styles, and an infrastructure for hosting the ePortfolios.

Academic Program Assessment:

As an extension of the ePortfolio initiative, the prospect of using the student ePortfolios as a vehicle for a more comprehensive assessment of program learning outcomes became a complementary objective by the department. This approach would provide a more reliable source as a means for collecting indirect measures to evaluate the success of the program outcomes. Information Systems programs accredited by academic boards such as ABET (Accreditation Board for Engineering and Technology) are required to provide tangible evidence showing both student and program learning outcome achievements.

Direct measurement is typically provided through curriculum assessment instruments, national certification tests, and comprehensive-semester project artifacts. Recent trends in evaluating Information Systems programs have included the request for tangible evidence specific in nature to the learning outcomes as identified in specific course syllabi. Semester projects that include definitive assignments with deliverables/artifacts are used to illustrate student expectations at outstanding, acceptable, and unacceptable levels of performance. Typically, hardcopy examples are assembled from each course instructor and provided to the accreditation team for review and quality assessment, confirming that the artifacts reflect the assignment requirements to ensure that the learning outcomes are met.

In addition to direct measures, comprehensive assessment standards incorporate indirect measures measured typically by program graduate (alumni) surveys, employer surveys and student marketability as measured by job offers/acceptance statistics. In concept, indirect measures are excellent, if not the best measures of assessing the success of information systems students, and importantly, program learning outcomes. New graduates are unknowns to their employers until 'on-the-job' assignments can be evaluated for quality based on completeness, accuracy, and meets the assignment requirements. This is the true testimony for student learning outcome assessment. Getting it 'right' is the level of achievement that is most sought as a measure that reflects the quality of the program. However, the difficulty has always been the ability to document these measures. Exit interviews provide a prior evidence that program assisted graduates gain employment; uncorroborated at best. Letters of employment offers and/or employer surveys would provide greater credibility of the measure. Tracking alumni through follow-up surveys is a reasonable sampling technique, but in most cases, falls short in effectiveness. Alumni are indifferent to surveys, often viewed as an invasion of privacy, time consuming, and of not high priority which causes problems in accurate data collection.

ePortfolios offer an approach that combines the advantages of direct assessment data collection and those of the indirect measures derived from external sources associated with program alumni after graduation would provide more creditable data for assessing program learning outcomes. This paper proposes implementing an ePortfolio approach for including these elusive indirect measures by using student e-Portfolios as an effective and efficient vehicle for collecting data to complement the direct measures that can be managed by the academic unit and instructional faculty.

e-Portfolio Approach:

The concept of student portfolios is not new and has been effectively used by other academic disciplines, most notably students majoring in fine arts, architecture, and engineering. These disciplines offer a much richer approach to portfolio construction as these discipline learning artifacts are tangible in nature. Engineering and architectural drawings, working prototypes, models, paintings, and clothing designs are typical indicators of the skills and knowledge that students majoring in these disciplines have acquired. Potential employers are able to assess job applicants based on the scope and quality of the brand skills displayed in the artifacts presented. Information Systems has not used this approach because the artifacts are virtual and less tangible than those in fine arts, education (teachers), engineering, and architecture academic programs. Plus, the challenge of establishing an infrastructure for hosting and managing the array of complicated artifacts discouraged support for the development of an e-Portfolio solution. Using a self-managed approach that uses existing infrastructures supported by established hosting services was the approach that was decided as the best mechanism for implementation.

Figure 1 represents a model developed by Helen C. Barrett (Barrett, 2010) for educators, focuses on two major purposes for developing ePortfolios, and how to balance both approaches to enhance student learning engagement using the ePortfolio process. For the ePortfolio project purposes, the Information Systems Department’s focus is on the ePortfolio as a showcase that uses a process for collecting and organization a set of artifacts that showcase the IS graduate’s academic achievements and technical skills.

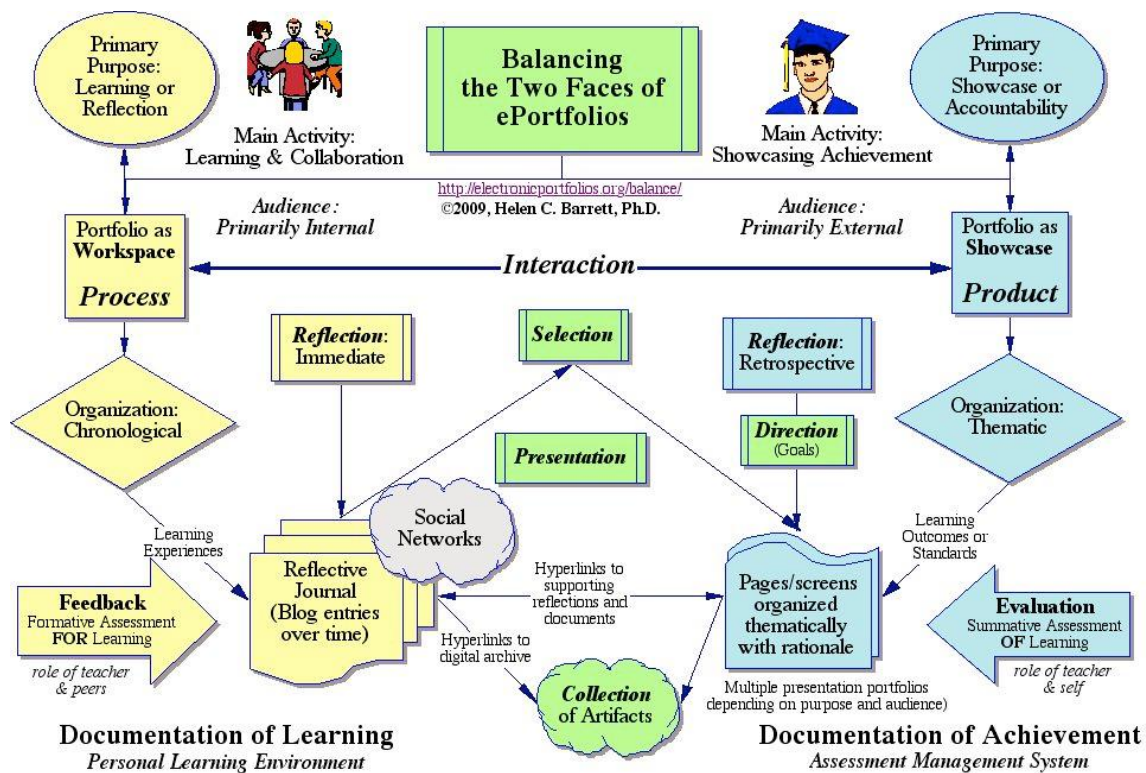


Figure 1
Balancing the Two Faces of E-Portfolios [Barrett, 2010]

Figure 2 (Barrett, 2010) offers a visual representation of the diversity of sources used in the artifact collection process. The important consideration when examining the process is the infrastructure necessary to implement the presentation of the collection of artifacts. Creating an ePortfolio as a compilation of work in a digital archive, stored on a server, whether locally or on the Internet represents the first step in the development process. Students must understand the attention to accuracy, significance of content correctness, and the importance of presentation layout and navigation. The role of faculty advisors is to acquaint students with the guidelines for identifying the types of artifacts to collect, organizing and presenting the artifacts in a coherent format. Reliance on a set of guidelines established to achieve this result is helpful for both student and faculty.

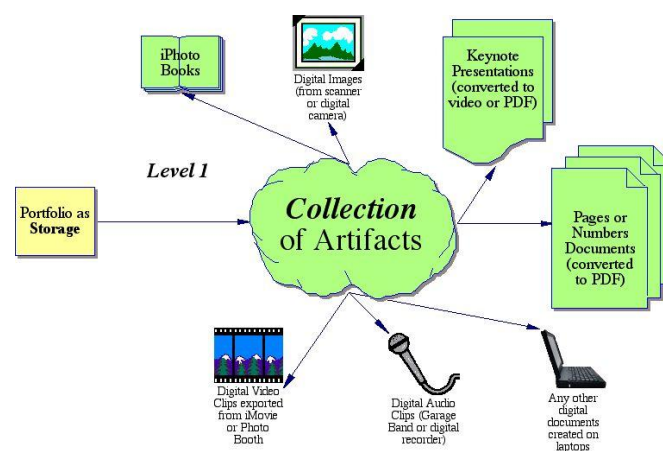


Figure 2 Artifact Collection Process (Barrett, 2010)

Social & Professional Media Networks as ePortfolio Vehicles:

Social networks have become the main vehicles for interaction on personal and professional levels. Personal social network media such as Twitter, Instant Messenger, and Instagram offer a limited direct communicative purpose rather than a media service that has the organizational capability to create, store and retrieve artifacts, and allows sharing. Facebook does allow for this capability, however, its primary purpose is for not professional connectivity; instead, a social discourse and personal portfolio is its objective.

A professional ‘social media’ network, LinkedIn, was chosen as the vehicle for implementing the ePortfolio initiative. LinkedIn is an established social media with over 300 million members in over 200 countries (LinkedIn, 2015), designed to support the networking of professionals who wish to share job-related experiences they have accumulated in their careers. In addition, LinkedIn offers the ability for self-management and minimum local hosting responsibilities which was an implementation mandated requirement.

Authors' note:

The full paper presents a procedure for incorporating LinkedIn as the vehicle to incorporate indirect assessment measurement methods. More specifically, a template and implementation model for self-managed E-Portfolios that present student brand skills and artifacts to demonstrate knowledge breadth and depth are being offered to information systems majors is presented. The following pages are drafts that include:

1. The process for information systems majors to create an E-Portfolio,
2. Guidelines for content to be include;
3. User guidelines and examples;
4. Information gathering forms for brand skills and portfolio artifacts
5. Sample student ePortfolio
6. Resource references (complete list in final version of paper/presentation)

The full paper will include the latest versions of the templates and guidelines for procedure and content, and presentation development, and implementation instructions will be presented at the meeting. Time did not allow for the final versions of these documents in order to include them in the proceedings.

A Guide on Improving the Marketability of VCU-IS Undergraduate and Certificate Students

Introduction

This document presents a proposed process to implement some important changes in the VCU-IS undergraduate and certificate programs in order to make students graduating in those programs more marketable from the perspective of potential employers. The important changes that are addressed in this document are concerned with three aspects that are named as: brand skills, portfolio items, and career roadmaps. On this basis, there are three major sections in this document that will be addressing the definition, purpose, change implementation process, and use guidelines with respect to each of the aforementioned three aspects.

Brand Skills

Definition and Purpose:

Brand skills are those specific, industry-wide-known, and marketable skills that IS undergraduate and certificate students would attain (at a full or partial level) by taking a certain IS undergraduate/certificate course.

The major purpose, on one hand, is to make students (as well as probably the employers community) aware of the skill set that can be expected to be attained by taking each certain IS undergraduate/certificate course, and, on the other hand, is to enable students to clearly address and include skill sets they have attained throughout their IS undergraduate/certificate program in their job seeking process by mentioning those skills on their resumes, on the other appropriate places such as their LinkedIn profile, and during their job interviews.

Implementation Process:

Each and every IS undergraduate/certificate course (excluding 100-level courses) must maintain a constantly up-to-date list of brand skills in all its course-related documentation including the course syllabus, the course descriptions on the IS department's website, and the university-wide bulletins (catalogs) and course descriptions.

A step-by-step process can be followed to craft and maintain an up-to-date list of brand skills for each IS undergraduate/certificate course:

- Step 1- a proposed (or changed) list of brand skills gets crafted by a team comprised of course instructors and the coordinator for each course
- Step 2- the course coordinator presents the list of the brand skills coming out as the result of step 1 to the IS Undergraduate Program and the IS Advisory Board committees in order to get those committees' approval
- Step 3- the approved list of brand skills at step 2 provide the basis for these two (possibly) concurrent actions:
 - A. the IS department staff will go through the CARF process to reflect the brand skills on the university-wide bulletins (catalogs) and course descriptions, and also will make any required change on the IS department's website in order to reflect on the brand skills information for each IS undergraduate/certificate course

course coordinators will become responsible to make sure that the skills are reflected in all course syllabi related to different sections of any given course, and that the brand skills and how students can leverage/use them in their job-hunting process/profile (see the Use Guidelines part below) are being communicated (to students) and emphasized appropriately and adequately by instructors in all different sections of any given course

User Guidelines:

The brand skills identified through the implementation process described above, then, could be used by students in order to make their own job-hunting profile more marketable. The most intuitive way for students to reflect on the skills they have attained throughout the program is to mention them on their own resumes and during their job interviews.

Additionally, students could use social media to promote their profile. The most appropriate social media tool seems to be LinkedIn. In this line, the brand skills attained by students could be shown up on their LinkedIn pages and under the section called "Skills," where seems to be the most appropriate section on LinkedIn for that purpose.

Portfolio Items

Definition and Purpose:

Portfolio items are those specific, industry-wide-known, and marketable deliverables/artifacts that students produce over the time period of a certain IS undergraduate/certificate course.

The deliverables could be the outcomes of class projects, homework assignments, etc. On this basis, by the end of the time period of any given IS undergraduate/certificate course, students will have produced one or more items which constitute their portfolio for that course.

The major purpose, on one hand, is to make students (as well as probably the employers community) aware of the actual and representable work/artifacts that can be expected to be produced by taking each certain IS undergraduate/certificate course, and, on the other hand, is to enable students to clearly address and include deliverables/artifacts they have produced throughout their IS undergraduate/certificate program in their job seeking process by mentioning those deliverables/artifacts on their resumes, on the other appropriate places such as their LinkedIn profile, and during their job interviews.

Implementation Process:

Each and every IS undergraduate/certificate course (excluding 100-level courses) must maintain a constantly up-to-date information regarding its portfolio item(s) in all its course-related documentation including the course syllabus, the course descriptions on the IS department's website, and the university-wide bulletins (catalogs) and course descriptions.

The information concerning the portfolio items has three important elements:

- **title of the item(s):** the title of expected marketable deliverable(s) that students will produce by doing projects, homework assignments, etc. in any given course
- **advice on making winning portfolio items specific to any given course:** guidelines on how students can make each of their portfolio items eye-catching and marketable for potential employers, e.g., in terms of the format of the presentation of material, things to focus on, etc.
- **a textual or graphical mapping which shows how one or more of the brand skills for a given course are addressed by each portfolio item for that course**

User Guidelines:

The portfolio items identified through the implementation process described above, then, could be used by students in order to make their own job-hunting profile more marketable. The most intuitive way for students to reflect on the portfolio items they have produced throughout the program is to mention them on their own resumes and during their job interviews.

Additionally, students could use social media to promote their profile. The most appropriate social media tool seems to be LinkedIn. There are two sections on LinkedIn that seem appropriate places as for presenting the portfolio items information. One section is called "Summary." This section is shown in figure 1 below. This section seems very appropriate for students to put their signature portfolio item(s) since LinkedIn allows for creating only one Summary item. The signature portfolio item(s) are those that a student is mostly passionate about and probably is the most relevant one(s) to the career track (see the Career Roadmaps section below) that that student wants to follow. As Figure 1 shows, students can have a description (summary) of their signature portfolio item(s), they can upload a file correspondent to their

Figure 1: The Summary section on LinkedIn

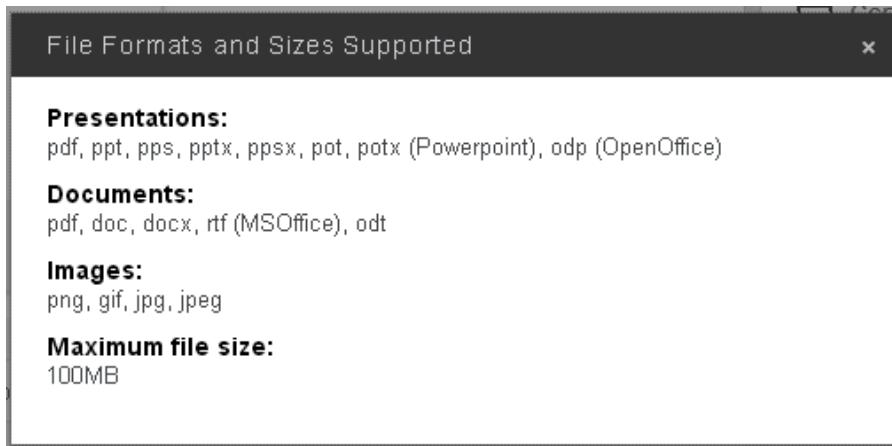



Figure 2: File formats and sizes supported to be uploaded on LinkedIn 5

signature portfolio item(s) (see Figure 2 as for the supported formats and sizes), and, finally, they can share a link which could provide more flexibility in terms of providing more material related to the portfolio since it could be a link to a cloud-based content storage place such as Dropbox.

 Projects + Add | ↑


Name *

Occupation

Date [Switch to date range](#)

Project URL

Team Member(s) *

 Kaveh Mohajeri + Add team member

Drag to reorder contributors.

Description

Students can present the rest of their portfolio items in another section on LinkedIn called "Projects." This section is shown in figure 3 below. Students can actually create multiple entries in this section reflecting multiple class projects or assignments they did throughout their undergraduate/certificate program. The appropriate undergraduate/certificate program can be selected by clicking on the Occupation drop-down menu. There is also a space for including a URL which could refer to material related to the portfolio item since it could be a link to a cloud-based content storage place such as Dropbox.

Figure 3: The Projects section on LinkedIn

The last point in this section pertains to the IS department responsibilities to reflect on the portfolios that IS students have. A page on the IS department's website should be devoted to showcase some signature portfolio items produced by IS students and provide any relevant information to those items such as web links.

Career Roadmaps

Definition and Purpose:

Career roadmaps are those specific, industry-wide-known, and marketable job titles (and also their respective descriptions) that portray different potential areas of employment for graduates of the IS undergraduate/certificate program. The following employment area titles are currently shown on the IS department website (<http://business.vcu.edu/infosys/557.html>):

- Computer Programmer
- Data Base Analyst
- Programmer Analyst
- Systems Analyst
- Manager, Information Systems
- Hardware or Software Sales Representative
- Technical Writer
- Systems Consultant
- Information Analyst

The major purposes of identifying and maintaining the career roadmaps are:

- ☑ to make students (as well as the employers community) aware of the possible employment areas for someone who is the graduate of the VCU IS undergraduate/certificate program
- ☑ to enable students to tailor/shape their job seeking profile (including their skills and signature portfolio item(s)) towards the career track they want to follow after their graduation
- ☑ to enable students to clearly address and include the career track they want to follow in their job seeking process by mentioning that on their resumes and during their job interviews

Implementation Process:

The list of career roadmap titles provided above is too general and does not reflect the character of the IS undergraduate/certificate program. The list should be changed/customized, and descriptions for each career roadmap item should be added too. Therefore, a step-by-step process should be followed:

- 1- a draft document composed of the titles of career roadmap items along with their respective descriptions should be prepared by the IS department. The description for each career roadmap item should include the following elements:
 - a. a statement on the general definition, importance, and prospect of the career roadmap item
 - b. required majors/courses
 - c. required skills (must match to the list of brand skills identified for IS undergraduate/certificate courses)
 - d. required portfolio item(s) (must match to the list of brand skills identified for IS undergraduate/certificate courses)
 - e. a list of suggested VCU or outside organizations beneficial to get involved with
 - f. sample local opportunities and potential employers
- 2- the draft document coming out as the result of step 1 should be presented by the IS department chair to the IS Undergraduate Program and the IS Advisory Board committees in order to get those committees' comments, and finally, approval
- 3- the approved document at step 2 will be the basis for the IS department to update the department's website to outline the career roadmaps and all relevant information on a separate webpage which will be prominently linked from the home page and anywhere else it would get attention

General Guidelines

This section provides some general guidelines with respect to the implementation of brand skills, portfolio items, and career roadmaps. The guidelines are:

- ☑ the first round of the implementation process for brand skills and portfolio items for each certain course could be consolidated and executed at the same time
- ☑ the IS department should collaborate with the business school career services center in order to educate students on how they can use social media, especially LinkedIn, in order to promote their own job-hunting profiles according to the *Use Guidelines* provided above
- ☑ the IS department should collaborate with the business school career services center in order to utilize social media, especially LinkedIn, to showcase IS undergraduate/certificate students' profiles, and most importantly their brand skills and portfolio items, in order to get more attention from the employers community

Brand Skills and Portfolio Items Information Gathering Form

Course Code: INFO [#]

Brand Skills

Definition and Purpose:

Brand skills are those specific, industry-wide-known, and marketable skills that IS undergraduate and certificate students would attain (at a full or partial level) by taking a certain IS undergraduate/certificate course.

The major purpose, on one hand, is to make students (as well as probably the employers community) aware of the skill set that can be expected to be attained by taking each certain IS undergraduate/certificate course, and, on the other hand, is to enable students to clearly address and include skill sets they have attained throughout their IS undergraduate/certificate program in their job seeking process by mentioning those skills on their resumes, on the other appropriate places such as their LinkedIn profile, and during their job interviews.

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TOWARDS A REVPAR APPROACH TO ESTIMATE WILLINGNESS-TO-PAY AND MARKET SIZE DISTRIBUTIONS

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ABSTRACT

The purpose of this paper is to develop an approach to estimate customer willingness-to-pay and market size distributions for a mid-market hotel and its competitive set. Actual hotel daily rates and occupancy data are used to estimate the results. The paper considers various types of demand distributions in order to maximize goodness-of-fit to observed rates and occupancies. Preliminary results are analyzed by day and month, and useful recommendations for hotel management are presented.

INTRODUCTION

The ability to accurately set rates and forecast demand is important for revenue management in the service sector. Successful revenue management programs can allow decision makers to forecast demand, allocate perishable resources (such as a hotel room night) across different rate segments, determine when and by how much to overbook, and decide what rate to charge to the different rate segments [1].

Airlines [2], cruise lines [3], hotels [4, 5] and car rental companies [6] are all traditional examples of service industries that have been able to improve profits with revenue management programs. Revenue management can then involve the complex overbooking methods found in the airline industry, or simpler price discrimination techniques such as those found in the hotel industry.

Hotel revenue management has been studied for many years and continues to be a research topic of interest [7, 8]. However, there appears to be a lack of quantitative decision models based on actual observed data. Baker and Collier [1], for example, propose a Price Setting Method and analyze its performance using simulated data. The model results can then be considered the upper limit of real life revenue increases.

In terms of models based on actual observed data, Koushik, Higbie [4] discuss the development of a price optimization model that determines optimal room rates based on occupancy data, constant price elasticity, and competitors' rates. The authors did not include in their model and subsequent analysis the idea of willingness-to-pay to support decision making.

Lee, Garrow [9] present an empirical analysis of booking curves, average paid rates and occupancy rates for different demand segments. The research tested traditional hotel revenue management assumptions. The authors analyzed, among other things, the relative differences between weekday and weekend demand and concluded that traditional industry assumptions should be made with caution. The authors also emphasize the need for models that are based on a clear understanding of how actual demand is affected by different market and price structures. Nevertheless, the authors acknowledge that effectively characterizing demand response to price is not an easy task.

RESEARCH METHOD

Demand Modelling

The purpose of this research is to provide decision support by estimating customer willingness-to-pay and market size distributions for a mid-market hotel and its competitive set. This research paper considers various types of demand distributions in order to maximize goodness-of-fit to observed rates and occupancies. A customer demand distribution can be used to characterize the Price Elasticity of demand (i.e., the relationship between a change in room demand quantity and a change in the room rate) of different market segments. This type of analysis can, in turn, help a decision maker estimate the maximum willingness-to-pay associated with a certain market segment.

Demand functions can thus be used to estimate willingness-to-pay. A linear demand distribution, for example, assumes customers have a single uniformly distributed willingness-to-pay. The example below illustrates a market size of 120 and a uniformly distributed willingness-to-pay between \$0 and \$150. The graph shows the correspondence between a uniformly distributed willingness-to-pay and the linear demand parameters.

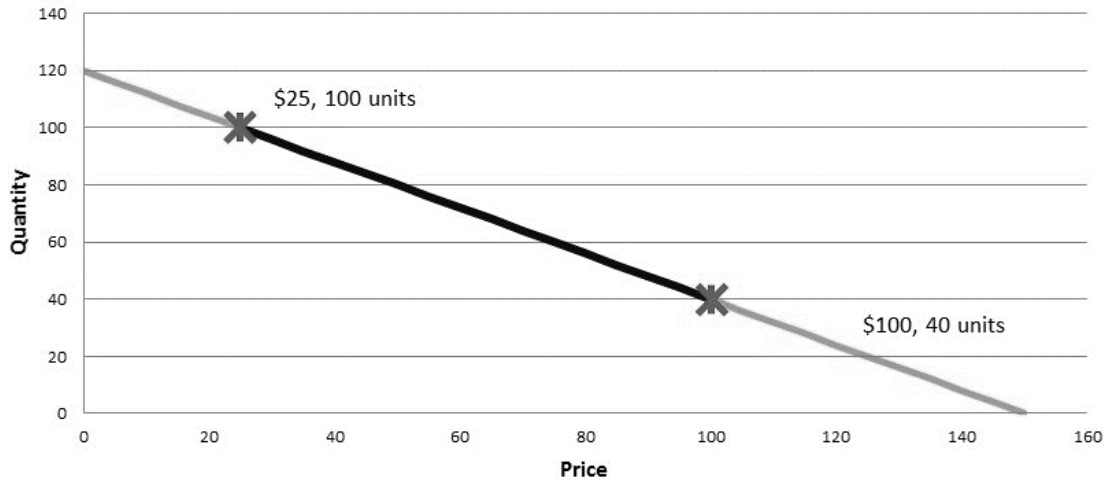


Figure 1: Linear Demand Function

The impact of pricing will depend on what demand distribution is used. For this reason, three alternative demand distributions are analyzed in this paper: a linear demand distribution and two non-linear demand distributions (normal and exponential). This analysis is based on fitting demand probability distributions to observed data as opposed to functions that rely on traditional assumptions that may not hold true in an actual real life hotel context [9].

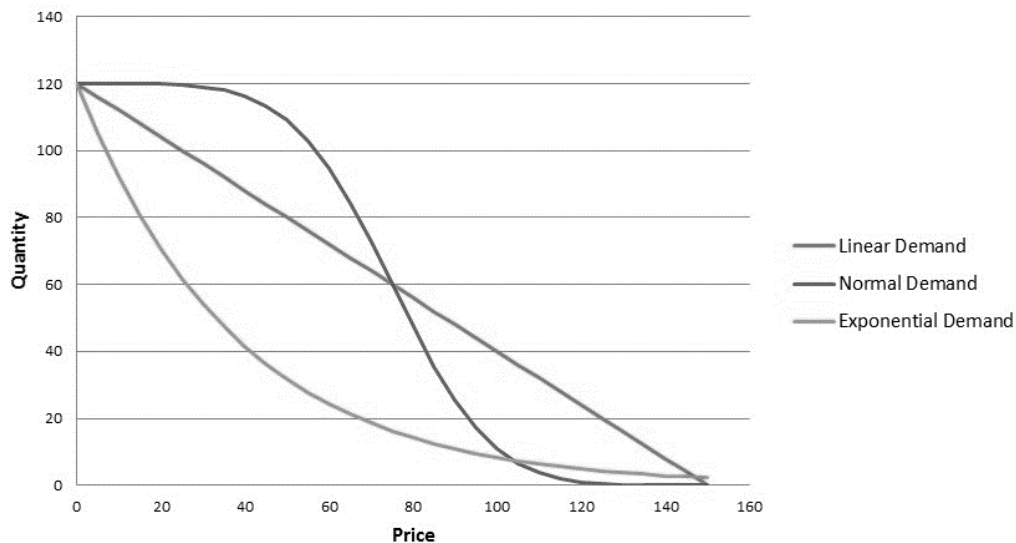


Figure 2: Alternative Customer Demand Distributions

Data

The data set used in this paper includes almost 800 paired observations of actual hotel daily rates and occupancy figures from a mid-market hotel and its competitive set. The observations span a period of over two years. A scatterplot of the data used in the analysis is presented below. The scatterplot displays the actual number of Rooms Sold corresponding to different Average Daily Rates (ADR).



Figure 3: Data Set

In the figure below, the data set is broken down into rate segments. The division of rates into segments represents an approach similar to procedures traditionally used in the hospitality industry [9].

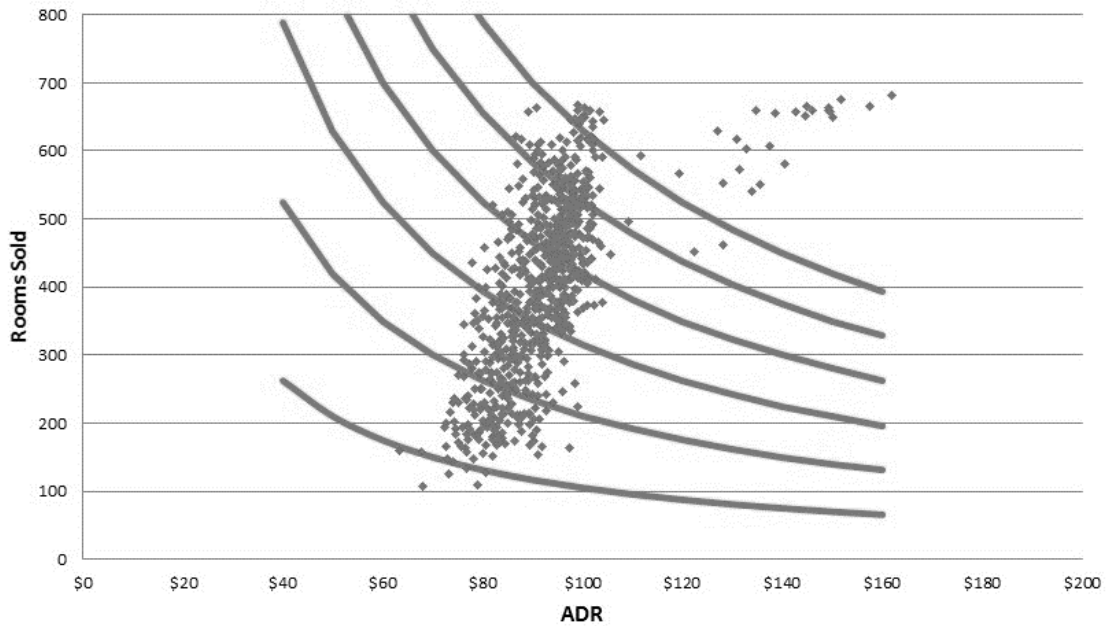


Figure 4: Rate Segments

Seven different segments are identified using \$15 increments of Revenue per Available Room (RevPAR). RevPAR is a traditional performance metric in the hotel industry calculated by dividing a hotel's total room revenue by the number of rooms available.

$$RevPAR = \frac{\text{Number of Rooms Booked} \times \text{Average Daily Rate}}{\text{Total Number of Rooms Available}} \quad (1)$$

Note that RevPAR is not the same as the Average Daily Rate (ADR). RevPAR is affected by the occupancy rate and, unless the hotel is working at 100% capacity, will typically result in a smaller figure (e.g., if a hotel is working at a 70%-80% occupation rate).

Model

The proposed decision model is formulated as an optimization model. The objective function seeks to minimize the Sum of the Squared Errors (SSE) by changing the number of rooms sold for the different segments as well as the parameters of the corresponding demand distributions. The linear model, thus, includes decision variables for the market size and the maximum willingness-to-pay associated with each segment. The normal model incorporates decision variables for the market size, the mean and the standard deviation corresponding to each class. Finally, the exponential model includes decision variables for the market size and the rate parameter, λ , associated with each segment.

The optimization model is finally subject to different segment size, rate and non-negativity constraints. The optimization model considers all seven segments in the objective function and the constraints. As a consequence, all seven rate segments can be solved simultaneously.

RESULTS

The problems were solved using the Risk Solver Platform from Frontline Systems, Inc. Figures with the preliminary results associated with the different demand distributions used in the problems are included below.

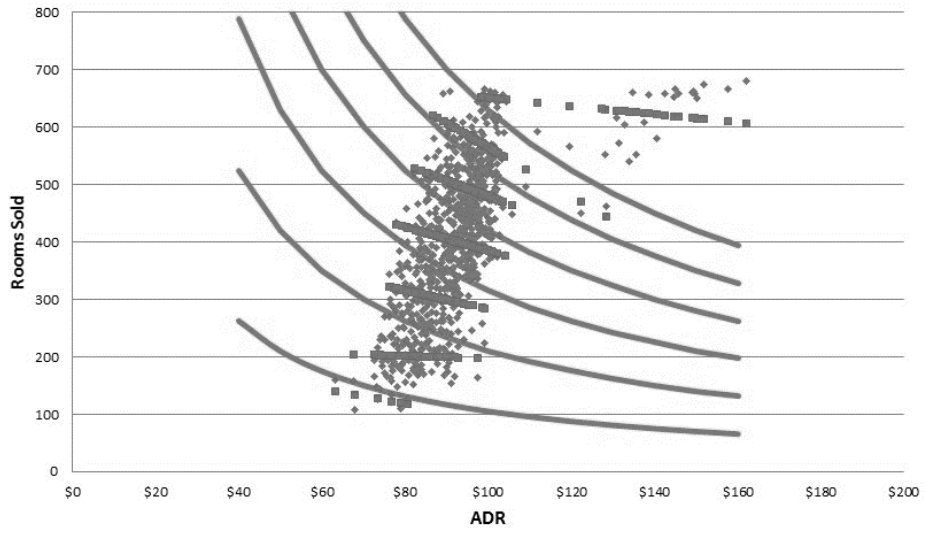


Figure 5: Linear Demand Estimates

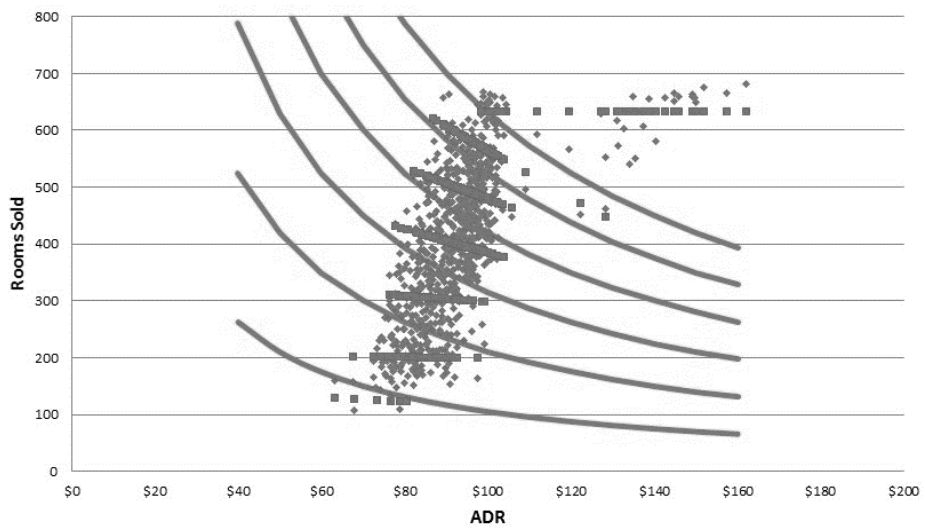


Figure 6: Normal Demand Estimates

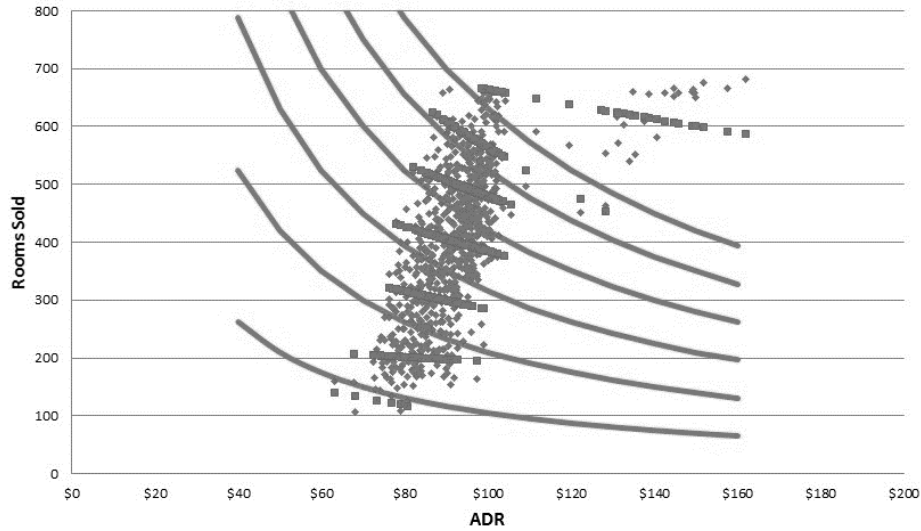


Figure 7: Exponential Demand Estimates

The model results allow the user to identify different market segment sizes. In the graphs above, the Y-intercepts for a segment's distribution can be interpreted as the potential market size, while the corresponding X-intercept would represent the maximum willingness-to-pay associated with the segment.

The results associated with the Linear demand function were the most accurate ones, fitting the data the best, with a Root Mean Square Error (RMSE) of 31.9. The resulting segment market sizes and maximum willingness-to-pay estimates are presented below (Note: \$--- indicates a rate that is impractically high).

| | Maximum Size | Maximum Willingness-to-Pay |
|------------------|---------------------|-----------------------------------|
| Segment 1 | 222 | \$86 |
| Segment 2 | 219 | \$--- |
| Segment 3 | 446 | \$137 |
| Segment 4 | 592 | \$143 |
| Segment 5 | 755 | \$137 |
| Segment 6 | 990 | \$116 |
| Segment 7 | 724 | \$--- |

Table 1: Maximum Market Segment Size and Willingness-to-Pay

Managerial Implications

From a practical management perspective, the model results can be used to derive useful recommendations for hotel managers. The table below displays how many observations fall in each day across the different market segments. This information can be used to look for specific rate pattern categories across the days of the week. For example, the results below indicate that, for this particular data set, Saturday and Sunday demands should not be grouped together as ‘Weekend’ demand, a traditional approach used in the hotel industry.

| | Days of Week | | | | | | |
|----------|--------------|-----|-----|-----|-----|-----|-----|
| | Sun | Mon | Tue | Wed | Thu | Fri | Sat |
| Market 1 | 4 | 2 | 2 | 1 | 2 | 2 | 1 |
| Market 2 | 60 | 11 | 4 | 4 | 9 | 11 | 13 |
| Market 3 | 38 | 9 | 10 | 7 | 33 | 33 | 31 |
| Market 4 | 4 | 55 | 21 | 22 | 41 | 31 | 29 |
| Market 5 | 8 | 33 | 49 | 48 | 17 | 19 | 20 |
| Market 6 | 3 | 4 | 21 | 22 | 8 | 9 | 12 |
| Market 7 | 7 | 2 | 6 | 6 | 3 | 12 | 11 |

Table 2: Cross Tabulation of Day and Market Segment

It can also be noticed that segment 2 seems to be primarily associated with Sundays while, on the other hand, segment 1 has a fairly random pattern. Decision makers can then combine the information presented in the last two tables to derive pricing guidelines.

Additional useful recommendations for hotel management can be derived from the model results. The figure below displays the average rate category across the different days and months of the year. Based on the model results, decision makers can also estimate average rate categories by both month and day of the week

| | Sun | Mon | Tue | Wed | Thu | Fri | Sat | |
|-----|-----|-----|-----|-----|-----|-----|-----|---|
| Jan | 2 | 4 | 4 | 5 | 4 | 3 | 3 | 3 |
| Feb | 3 | 4 | 5 | 5 | 4 | 4 | 4 | 4 |
| Mar | 2 | 4 | 5 | 5 | 4 | 3 | 4 | 4 |
| Apr | 2 | 4 | 5 | 5 | 4 | 4 | 4 | 4 |
| May | 2 | 4 | 5 | 5 | 4 | 5 | 5 | 4 |
| Jun | 3 | 4 | 4 | 5 | 5 | 4 | 4 | 4 |
| Jul | 3 | 4 | 5 | 6 | 5 | 5 | 4 | 5 |
| Aug | 3 | 4 | 5 | 5 | 4 | 4 | 4 | 4 |
| Sep | 3 | 5 | 5 | 5 | 5 | 6 | 6 | 5 |
| Oct | 4 | 4 | 5 | 5 | 3 | 5 | 5 | 5 |
| Nov | 2 | 4 | 5 | 5 | 4 | 4 | 5 | 4 |
| Dec | 2 | 3 | 3 | 4 | 3 | 3 | 3 | 3 |
| | 3 | 4 | 5 | 5 | 4 | 4 | 4 | |

Table 3: Average Rate Category by Month and Day of the Week

In the hotel industry, initial room rates must be set several months in advance (330 days in advance in some cases). Hotel managers can use the information presented in the chart above as a useful guide to set initial hotel rates, basing their decisions on estimated segment sizes and customers' willingness-to-pay.

CONCLUSIONS

In order to use pricing as a tool for maximizing profit, revenue management models in the hotel industry must accurately represent the relationship between demand and price. This research represents the initial step towards the development of a model to estimate customer willingness-to-pay and market size distributions for a mid-market hotel and its competitive set.

In that particular context, an optimization model was proposed and different demand distributions were used to generate the results. Estimates were based on actual observed average daily rates and hotel occupancy data over a two-year period. The subsequent discussion illustrated how managers may use the model results to support pricing decisions in the hotel industry.

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What are the Cash Flow and Tax Burden Effects of Removing Large Party Service Charges from Tip Income?

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ABSTRACT

Rev. Rul 2012---18 indicates that, beginning in 2012, a stipulated “tip” typically added to the check of larger parties is a service charge, and not considered a tip. As such, the “service charge” is wages, rather than tip income and it is removed from reported tips and the related sales are removed from the calculations for purposes of reporting tips. In this project the cash flow effects and the tax burden are calculated for the server and the restaurant.

INTRODUCTION

On June 26, 2012, the Internal Revenue Service issued a ruling indicating that, beginning in 2012, a stipulated “tip” typically added to the check of larger parties is a service charge, and not considered a tip under Rev Rul 2012---18 [http://www.irs.gov/irb/2012--26_IRB/ar07.html]. As such, the “service charge” is wages, rather than tip income; it is removed from reported tips and the related sales are removed from the calculations for purposes of reporting tips.

Say, for example an employee has sales of \$100,000 for a year, and total “tips” of \$13,000 [13%]. Twenty percent of the sales are subject to a “service charge” of 18 percent. After removing these sales and tips, the employee’s sales are \$80,000 and the “tips” are \$9,400 [11.75%].

Servers whose reported tips are less than 8 percent of their sales are allocated tip income to the extent of the difference (unreported tips). If the tips under the above formula are below 8 percent, removing service charges can have a significant effect.

Additionally, Sec. 45B allows a credit for payroll taxes on tip income. This Rev. Rul. that removes “service charges” from “tips” has the effect reducing this credit.

THIS PROJECT

This project will involve determining the cash flow effects to the employee and the employer. The approach will be to do calculations for servers in three groups:

- 1) Servers with reported tips below 8%
- 2) Servers with tips approximating tips of 15%

The results will be used to address the compensation patterns in restaurants and the revenue effects for the government.

Estimates as to the demographics of the U.S. restaurant industry were found at:

<http://pdccapitalgroup.com/restaurant---trends//>

“ . . . the Single Location Full---Service Restaurants industry experienced a major slowdown due to the struggling economy. However...as consumer spending rebounds...(0)ver the five years to 2012, IBISWorld estimates that industry revenue will grow at an average annual rate of 0.6% to \$94.0 billion. After declining 4.2% to \$85.4 billion over 2009, revenue grew for the first time in four years in 2010 and 2011, and it is expected to continue its upward trajectory in 2012 with revenue growing 2.8%.

“The Single Location Full---Service Restaurants industry consists of owner--- and family operated restaurants that are independent of chain or franchised networks. In general, operators are small businesses, so the industry is fragmented and highly competitive.

“The average establishment generates revenue of about \$460,000 and employs 12 people; however, some large operators have far higher annual revenue. Operators with five or fewer establishments that are not part of a chain can pull in annual revenue ranging from \$11.0 million to \$60.0 million...In the five years to 2017, industry revenue is forecast to grow at an average annual rate of 2.7% to \$107.3 billion.”

AN EXPLORATION OF ATTRIBUTES ASSOCIATED WITH SUCCESSFUL ONLINE MBA STUDENTS

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ABSTRACT

The influx of online courses has prompted academicians to research behavior patterns and inherent factors that could impact a student's likelihood of success in an online environment. Since there generally is a higher failure rate in online quantitative courses as compared to non-quantitative face-to-face classes, there is a pressing need to improve student success and retention rates in distance education programs; consequently, we are in the initial stages of our research to explore factors and behaviors that could impact a student's performance in online quantitative MBA courses. Three Management Science courses were examined to ascertain whether an overall combination of GPA, age, gender, cumulative credit hours and number of current semester hours impacted whether students passed the course. A regression analysis and descriptive statistics were also used to compare the average time spent completing homework and number of weekly Discussion Board posts for students who ultimately passed the course vs. those who failed (or withdrew from) the course.

Keywords: Distance education, student retention, quantitative online course, student success factors

INTRODUCTION

Many academic institutions have expanded their typical course offerings to include both traditional and online modalities. Multiple course delivery modes have impacted the variety of classes offered and overall student enrollment at high schools, vocational programs and universities. In general, online and hybrid courses have allowed institutions to reach varying demographics that would be unable to enroll in traditional degree programs. While online courses have their benefits, the ongoing challenge has been to maintain the rigor, standards, academic performance levels and overall student satisfaction of distance education courses as compared with face-to-face courses. Research has indicated that there are apparent disparities in how students perform in online quantitative vs. face-to-face classes [6][7][8]. With the growing number of distance education courses and the aforementioned challenges that are inherently connected with this modality, there are two questions that necessitate further probing: 1.) In what ways can an instructor enhance the overall experience of students in an online environment? and 2.) In what ways can students increase their likelihood of success in an online environment? For the purpose of this research, we are focusing on the latter question. The objective of this research is to explore factors before and during a course that could impact a student's performance. Although this is the first stage of our research, the ultimate goal is to develop a student success guide that could be used to advise students about taking online courses and improve overall retention rates.

LITERATURE REVIEW

The last decade has seen considerable growth in the number of online courses offered throughout academia [5]. In comparison to traditionally administered courses, research indicates that online classes have significantly higher dropout rates [6][7]. The emergence of increasing accountability standards for accreditation agencies have led educational institutions to seek solutions to decreasing the learning gap between online and traditional classes. One approach involves focusing on designing online courses using best practices, while implementing Learning Management Systems (LMS) and/or blended delivery models [2][8]. Alternative research seeks to evaluate learner behavior patterns in an effort to predict characteristics that lead to successful and unsuccessful performance through the use of surveys and learning analytics. Learning analytics is defined as “the measurement, collection, analysis, and reporting of data about learners and their contexts, for the purposes of understanding and optimizing learning and the environments in which it occurs” [9]. Many LMS such as Blackboard, Moodle, and Sakai have options which will allow professors to collect (and track) specific data regarding a students’ use of online resources.

Research suggests that finding clever ways to utilize learning analytics can lead to improved student performance and retention rates [4]. Specifically, learning analytics can be used to extract data and detect early performance patterns that can lead to poor course performance. Implementing an early detection/warning system could allow instructors to intervene and redirect students during a course, giving them a higher likelihood for successfully completing the course if immediate corrective action is taken. Intervention methods could include suggesting relevant learning resources, in addition to making students aware that their current activities (or inactivity) will statistically lead to an undesirable course grade if behavior patterns are not improved.

Davies and Graff [3] analyzed student performance in an online class, focusing on the relationship between student interaction in the course (measured by their discussion board participation) and their final grades in the class. They also analyzed students’ overall blackboard activity (i.e. accessing course content, submitting assignments, etc.). Their research showed that students that passed the course had higher blackboard activity when compared to students who failed (or withdrew). Similar patterns existed when analyzing discussion board activity for students that passed the course vs. students that were unsuccessful.

Michinov et al. [10] conducted an in depth study to investigate the impact of effective time management on course performance. Specifically, they researched the relationship between procrastination and course performance (grades). Course instructors gave surveys to students before starting class and another short survey after class requirements were completed, but before grades were issued. Both surveys asked students about different aspects of procrastination characteristics. Students were encouraged to participate in weekly discussion boards in order to complete case study assignments; however, their participation was voluntary and not graded. Their research revealed that students with higher procrastination tendencies, experienced lower grades, and conversely students that were prompt and had low procrastination behaviors earned higher course grades. Additionally, they found that the frequency of student participation in discussion boards had a positive correlation with their final course grade. Smith et al. [11] found that a student’s pace for completing assignments, how often they logged on to their LMS, and specific assignment grades successfully predicted their performance in the course. Their research confirmed that utilizing learning analytics could yield promising results for predicting (and improving) student success and retention.

Professors at Purdue University created a student success system, Course Signals (CS), which utilized data mining and statistical techniques to extract learning analytics from their Blackboard LMS courses in order to predict when students were falling behind [1]. Their technique calculates a student’s risk factor based upon their performance (current grades), effort (interaction with Blackboard), prior academic history, and demographic information. Once a student’s risk factor is computed, a green, yellow or red light signal is displayed on the student’s course home page. A green light indicates that the student is on track for successfully completing the course; a yellow light warns students that they are exhibiting some behavior patterns that could inhibit their success; and red light signals a high likelihood of being unsuccessful in the course if immediate action is not taken. Student risk factors were updated in fixed intervals throughout the course. Their research revealed that courses that implemented CS experienced “a strong increase in satisfactory grades and a decrease in unsatisfactory grades and withdrawals, when compared to previous semesters of the same courses not using CS.”

Dietz-Uhler and Hurn [4] reported the analysis of student grades on specific course assignments in a 2012 study which investigated patterns that could predict their course performance. Their study found that student performance on an introductory quiz (about the course syllabus), the first two exams, and select assignments in the second half of the course accounted for 98% of the variance in final course grades. Their results indicated that it could be beneficial to examine student performance indicators and behaviors at key points during a course in order to improve student performance.

Our research will focus on utilizing learning analytics to search for behavior patterns which lead to successful and unsuccessful course performance in specific MBA courses. Through understanding student behaviors and practices in these courses, we aim to assist future students with avoiding common pitfalls, and successfully navigating through our academic program.

DISCUSSION/RESULTS

We began our exploratory study by examining 3 Management Science courses in an online MBA program taught by a single professor. Characteristics such as GPA, age, gender, number of credit hours completed and number of current semester hours were all considered potential factors that could impact student success in the course. Student success was measured by whether the student earned a passing grade (A, B or C) or was not able to successfully complete the course (F or Withdrawal). Data that could uniquely identify the students was omitted so that anonymity was maintained. Table 1 provides details about the sample of subjects in this study. Fifty eight percent of the students were male and the average age of those enrolled in the course was 33. The average cumulative GPA was 3.65 (prior to taking the course). Also, eighty seven percent of the students took this Management Science class after completing 3 or fewer courses in the MBA program.

Table 1: Details about sample of 45 subjects

| Sample size (n=45) | | | | | |
|---------------------------|----|--|-------|---|------|
| Females | 19 | Average age | 33.78 | GPA | 3.65 |
| Males | 26 | Average cumulative credit hours completed | 7.51 | Average number of current semester hours | 5.42 |

GPA, age, gender, cumulative credit hours completed, and number of current semester hours, are all independent variables that may have impacted whether students passed or failed Management science (the dependent variable). ANOVA, multiple regression and t-tests were used to explore possible factors that could impact the course grades. The results of a multiple regression analysis are provided in Table 2. The F-test from ANOVA (p-value=0.422) reveals that the course grade was not significantly impacted by an overall combination of GPA, age, gender, cumulative credit hours and number of current semester hours. These results were not intuitively obvious because we expected the GPA to have been a statistically significant factor that influenced whether students passed or failed the course.

Table 2: Results of Multiple Regression Analysis

| | | ANOVA | | |
|------------------------------|--------|---|-----------------------|----------------|
| | | F | Significance F | |
| Regression | | 1.506 | 0.422 | |
| Regression Statistics | | | t Stat | P-value |
| Multiple R | 0.5823 | Intercept | 1.696 | 0.0921 |
| R Square | 0.3390 | Gender | 0.111 | 0.9118 |
| Adjusted R Square | 0.3170 | Age | 0.517 | 0.6063 |
| Standard Error | 0.2584 | Number of Current Credit semester hours | -0.5083 | 0.6120 |
| | | Cumulative Credit Hours | 1.0256 | 0.3067 |
| | | GPA | 1.2934 | 0.3996 |

We also wanted to use descriptive statistics to compare two distinct groups of students –those who passed the class vs. the ones who failed (or withdrew) from the class. Table 3 summarizes characteristics from these two groups. Specifically, the average age, credit hours completed, current credit hours, time spent completing homework and number of weekly Discussion Board (DB) posts for both groups of students in the Management Science classes are provided in Table 3. The average time spent completing homework and number of weekly DB posts were determined using the analytics data from Blackboard. The most revealing findings from Table 3 indicate that the average age and GPA is higher among students who passed the course. Also, it appears that students who were not successful spent less than 2 days on homework where as those who passed spent over 5 days working on the assignments.

Since there is a relatively small sample size here, we understand that our research is somewhat limited. Our primary goal was to simply explore potential factors that could impact a student’s ability to successfully complete a Management Science MBA course at the research institution. The discernable differences between the average time spent working on homework and the number of weekly DB posts, provide insight as to what common pitfalls students should avoid.

FUTURE RESEARCH DIRECTIONS

Our research serves as an initial starting point to learn how analytics can be used to search for behavior patterns which lead to successful and unsuccessful course performance in quantitative business courses. For a sample of 45 students enrolled in an online Management Science course, we found that the GPA, age, gender, cumulative credit hours and number of current semester hours, did not significantly impact whether a student passed the course. We also noticed there was a significant disparity between the

average amount of time students spent working on assignment and number of weekly DB posts among those who successfully passed vs. failed (withdrew from) the class. We recognize that this is a small sample, with some very telling implications, that will serve as the impetus to collect more data. Through understanding student behaviors and practices, we aim to use this information to develop a student success guide that could assist future students with avoiding common pitfalls in quantitative online classes. In the future, we plan to collect data from a variety of online quantitative classes, so that we can conduct a more comprehensive analysis about behavior patterns of students who successfully complete these courses.

Table 3: Comparison of characteristics of students who passed vs. failed (or withdrew from) the course

| | Average age | Average cumulative credit hours completed | Average number of current credit hours | Average GPA | Average time spent working on assignments (days) | Average number of weekly posts on DB |
|----------------------------|--------------------|--|---|--------------------|---|---|
| Students who passed (n=40) | 29.21 | 7.52 | 5.34 | 3.68 | 5.72 | 5.60 |
| Students who failed (n=5) | 34.35 | 7.43 | 6.01 | 3.47 | 1.89 | 1.27 |

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IMPLEMENTATIONS FOR A SUSTAINABLE COMPANY

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ABSTRACT

Purpose of the Manual is to provide The Food and Drink Forum with ideas and techniques to further lead by example through setting the way for their business partners through sustainable practices to gain recognition for green initiatives.

The Forum is lead by an industry Board sourced from regional businesses, academic institutions and other key bodies involved in food and drink manufacturing and its supply-chains. They strive to always ensure the Forum's services and funded support are reflective of businesses' needs. Working with national funding bodies, local and regional economic development agen-cies, local councils and, most importantly, the businesses within the sector, the Forum continues to stimulate and support the sustainable development of the industry.

Benefits of Sustainability

Financial

- **Reduced Energy and water usage and costs**
- **Reduced paper and waste associated**
- **Grants available for improvement**

Brand and Reputation

- **Increased marketability**
- **Improved competitiveness**

Environmental

- **Reduction in carbon footprint**
- **Paper and resource efficiency**
- **Reduced emissions**

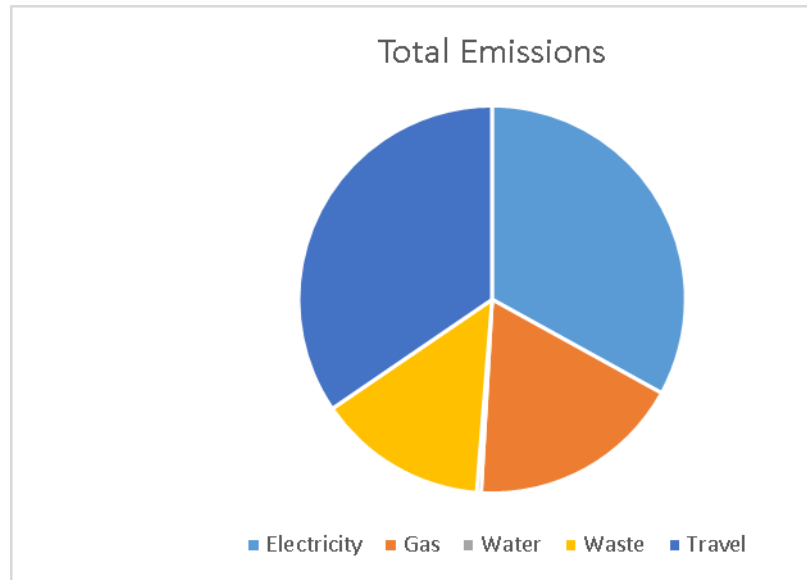
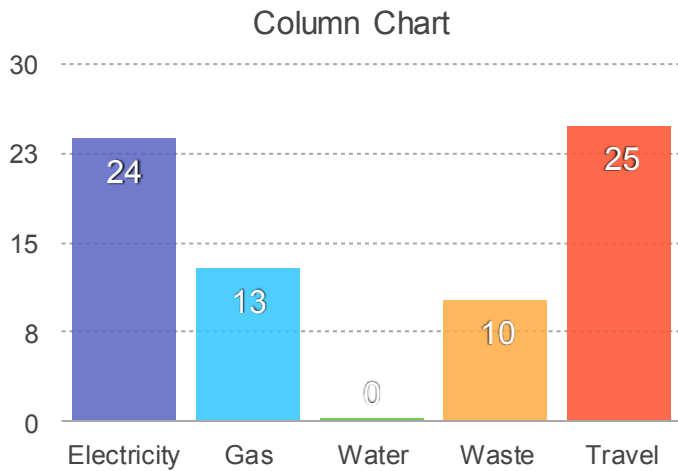
Human Resources

- **Improved working conditions**
- **Increase productivity**
- **Increased staff loyalty**

EXECUTIVE SUMMARY

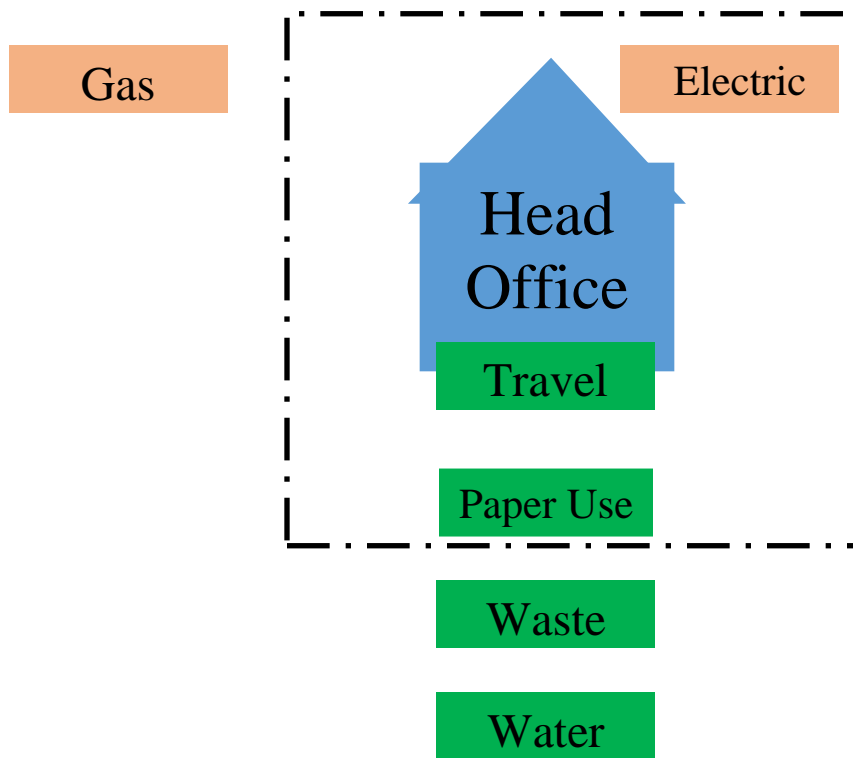
Column, bar, and pie charts compare values in a single category, such as the number of emissions emitted by each scope from 1 to 3 (Gas, electric, water, waste, transportation) in relation to how much they input.

| Sources | Tonnes of CO2 Equivalent Emissions | Costs Associated With Use (In Pounds) |
|-------------|------------------------------------|---------------------------------------|
| Electricity | 24 | 4790 |
| Gas | 13 | 1826 |
| Water | 0 | 704 |
| Waste | 10 | |
| Travel | 25 | 23114 |



MEASURING AND CALCULATING GREENHOUSE GASES

Emission Sources and Operational Boundary for the Food and Drink Forum



Scope 1

Scope 2

Scope 3

| | | Carbon Factor (Kilo-grams CO2 per unit) |
|--------|---------------|---|
| Travel | Car | 0.306164 |
| | Train | |
| | Taxi | 0.04904 |
| | Bus | 0.20208 |
| | | 0.123218 |
| Energy | Gas | 0.18404 |
| | Electric | 0.44548 |
| Waste | General Waste | 0.21 |
| | Paper | |
| | Mixed | |

Conversions

Travel

1. Cars: $(.306164)(49802 \text{ miles})(1.60934 \text{ km})/1000= 24.538 \text{ kgCO}_2$
2. Trains: $(.04904)(3248 \text{ miles})(1.60934 \text{ km})/1000=.256 \text{ kgCO}_2$
3. Taxi: $(.20208)(15 \text{ miles})(1.60934 \text{ km})/1000=.0048 \text{ kgCO}_2$
4. Bus: $(.123218)(15 \text{ miles})(1.60934 \text{ km})/1000=.00297 \text{ kgCO}_2$

Energy

5. Gas: $(.18404)(169,830 \text{ kwh})/1000= 12.85 \text{ kgCO}_2$
6. Electric: $(.44548)(53,259 \text{ kwh})/ 1000= 23.72 \text{ kgCO}_2$

Waste

7. General Waste: $(1.249\text{m})(.26)(21)= 6.819 \text{ kgCO}_2$
8. Paper: $(.519\text{m})(.2105)(21)= 2.294 \text{ kgCO}_2$
9. Mixed: $(.259\text{m})(.2)(21)= 1.087 \text{ kgCO}_2$

TARGETS

We have set environmental improvement objects and targets as part of our commitment to continually help The Food and Drink Forum's environmental performance. The information is gathered a emissions baseline carbon footprint analysis.

We are committed to reduce our environmental impact by at least 5% annually wherever practicable.

ACTION PLAN

These essential actions will be reviewed and updated annually to ensure they are maintained. Andrew Collinson will be in charge of delegating the responsibilities to the employees to take action.

Electric Alternative

Assuming there are 100 existing CFLs with 35 Wattage. To calculate the watt for the year we would take a 40 hr work week and times it 52 weeks in a year. Then to get the number of watts for 100 light bulbs we times 100 by 35. When then divided that number by 1000 to get the kilowatt hours.

$$(40 \times 52) + (100 \times 35) / 1000 = 7,280$$

Carbon emissions for this is:

$$.44548 \times 7280 \text{ kwh} / 1000 = 3.24 \text{ kgCO}_2$$

For the comparison with LED 20 Wattage bulbs we used the same process as before:

$$(40 \times 52) + (100 \times 20) / 1000 = 4,160$$

Carbon emissions for this is:

$$.44548 \times 4,160 \text{ kwh} / 1000 = 1.85 \text{ kgCO}_2$$

Payback

To calculate the estimated payback period we took the differences from CFLs and LEDs and multiply the cost per kwh (0.106) for The Food & Drink Forum to then divide it by 100 to get the 3 year payback period.

$$(7280 - 4160) \times (0.106) / 100 = 3.3 \text{ years}$$

(cost/kwh provided by Nottingham Energy Partnership)

| Resource | Task/Action | Proposed Completion Date |
|-------------|---|--------------------------|
| Electricity | To fit smart temperature and power metering | January 2015 |
| | To use smart metering to target reductions in our heating, cooling, and power use through behavior change by 5% | Quarterly |
| | Switch to energy efficient light bulbs | December 2014 |
| | Building Walk-thru; checking on lighting making sure it is off not in use | Weekly |
| Gas | incentives for employees | Quarterly |
| | To develop a heating and cooling protocol to regulate the temperature of the office | October 2014 |
| Marketing | Send emails to members, clients, and employees on updates and work | Monthly |
| | Ads on website showing green initiatives | Quarterly |
| | Email stories of successful and progress to clients | Monthly |

TRAVEL PLAN

Given the provided data from April 2013 to March 2014. Car travel produced 49,802 miles. According to the Nottingham Energy Partnership (NEP) the cost of driving 1 mile = 16.53 pence. The Food and Drink Forum can experience a savings of up to 15% which is £1,234.84 (£8,232.27 x .15) in their traveling by following the tips below provided by the Energy Saving Trust:

- **Switch it off** – If it is safe to do so, turn off your engine when stationary for more than a minute or two. Modern cars use virtually no extra fuel when they're re-started without pressing the accelerator so you won't waste lots of fuel turning the car back on.
- **Shift to a higher gear as soon as possible** – Driving at lower engine speeds reduces fuel consumption. Change up a gear between 2000 and 2500 revolutions per minute (rpm).
- **Drive smoothly** – Anticipate the road as far ahead as possible to avoid unnecessary braking and acceleration. Decelerate early when slowing down.
- **Slow down** – Avoid excessive speeds when possible. Driving at 85mph uses approximately 25% more fuel than 70mph.
- **Close your windows if travelling at 60mph or more** – The aerodynamic drag on your car of an open window at speeds of 60mph or more adds to your fuel usage. Keep your windows closed at high speeds

The Food and Drink Forum as well has an option of enrolling in Fuel Good Efficient Training which will provided them with methods for on the road travel to benefit in the long-term savings. The minimum cost for is £300 plus VAT. The savings will be translate into lower mileage and help with the annual goal of emitting 5% less in CO2 gases.

ENVIRONMENTAL POLICY

The Food and Drink Forum Environmental Statement

The Food and Drink Forum aims to minimise the impacts of its activities on the environment. Whilst working towards sustainable development, the Food and Drink Forum will work to continuously improve its environmental performance through the implementation of the following policies. These policies are summarised in, and reinforced by a commitment to:

1. promote environmental awareness within the Food and Drink Forum, on the Southglade Food Park and to our members
2. promote and encourage continuous environmental improvement within The Food and Drink Forum & on the Southglade Food Park
3. make the most efficient use of energy
4. source sustainable alternative energy supplies where possible
5. encourage walking, cycling and the use of public transport as alternatives to the private car
6. minimise pollution
7. avoid waste and encourage conservation, re-use and recycling resources
8. avoid the purchase of tropical hardwoods and to give a preference to FSC Trademark products
9. promote the purchase of goods and services that are 'environmentally friendly'

Issued by Senior Technical Manager, Richard Wigley
Authorised by Managing Director, Fiona Anderson

Waste

Policy Aims:

1. to minimise the amount of waste being produced and disposed
2. to maximise the promotion and use of recycled goods
3. to apply the 4 R's – Reduce, Reuse, Recycle and Repair, at all times

The amount of waste generated is constantly increasing and the majority of this is currently disposed of in landfill. Furthermore, the Government continues to increase landfill tax to encourage more sustainable methods of waste management, such as waste minimisation and recycling.

This policy will help the Food and Drink Forum reduce the amount of waste generated and support markets for recycled goods by purchasing them.

Action:

When purchasing, always consider whether you really need the purchase and in what quantity
Seek to maximise the use of products that are made from recycled materials and can be recycled after use

Southglade Food Park

Provide the facilities to segregate cardboard & outer packaging and use a licensed recycling contractor

Use fat trap interceptors to remove effluent solids and use a licensed waste contractor to put through a licensed digester

Provide the facilities to segregate plastics and shrink wrap and use a licensed recycling contractor (when volumes are achieved)

Office

Minimise the use of single use disposal items such as post it notes

Save and re use items in the office, such as paperclips and elastic bands

Before disposing of old equipment firstly check to see if it can be repaired then ask if anybody can use it

Use a mug or cup for hot drinks instead of the vending machine cups

Use a reuse cup instead of plastic cups for water

Where possible buy items in bulk to reduce packaging

Check mailing lists/distribution lists to make sure only the number of magazines or publications needed are received

Use internal post envelopes or re-use envelopes

Reuse the reverse side of printed paper as scrap

Use the internal recycling scheme and recycle cans, glass and paper

Energy

Policy Aims:

to consider the use of alternative energy sources when looking at energy supply options (such as solar energy)

to purchase 'energy efficient' equipment wherever possible

to promote energy efficiency within offices and buildings

to promote energy efficiency and alternative sources of energy

The Food and Drink Forum aims to contribute towards the reduction of the over all production of greenhouse gases and natural resources depletion, by reducing the amount of energy used within the running of the Food and Drink Forum buildings and the Southglade Food Park.

Action:

Inform, train & mentor all Southglade tenants to minimise energy use

- Provide quarterly training and information to tenants and employees through the Commercial Manager

To encourage Southglade tenants to use Government energy reduction initiatives and advice services & to purchase energy efficient products

- Provide monthly updates through email of Government energy initiatives

Use timers for external lights in line with seasons at the Southglade Food Park

- Use natural sunlight in line with seasons through opening blinds and windows

Use energy efficient light bulbs in all external & internal areas

Ensure 'power down' options are activated on electrical equipment

Buy energy efficient products

Adjust valves on radiators rather than opening windows to control heating

Ensure the alternative/new systems for energy production or usage are considered when performing work on major energy users such as heating boilers

Only fill the kettle for the number of drinks needed

Turn lights, fans etc off when leaving rooms

Whenever possible use the stairs instead of the lift

If you are leaving the office for long periods of time, turn off the computer, printer etc

Definitions:

Climate Change – a change in normal weather patterns in, for example, increased or reduced temperatures, increased sea level, higher incidence of flooding, higher rainfall or drought

Green Energy – generation of electricity from renewable sources such as wind, biomass, landfill gas, solar and hydro

Greenhouse Gas – Chemical gases released into the atmosphere that contribute to the process of Climate Change

Photovoltaic cells – ranging in size from similar to a roof tile to cladding on a building, Photovoltaic cells convert light into electricity, similar to the panel on a solar powered battery.

Ozone –depleting Chemicals

Policy Aims

1. to encourage the purchase and use of products that do not contain ozone- depleting chemicals in any firm unless there is no alternative
2. to specify within contracts that the use of products containing ozone-depleting chemicals is prohibited, unless it is essential or an alternative is unobtainable.
3. To ensure the correct disposal (and minimisation of environmental damage) of any products acquired by the Food and Drink Forum that contain ozone depleting chemicals

This policy aims to reduce the Food and Drink Forum contribution to ozone depletion. Ozone depletion allows an increase in UV-B exposure, this in turn can increase the risks to human of eye cataracts, skin cancers and suppression of immune responses. UV-B may also damage plants, the young stages of aquatic animals and other wildlife.

The most commonly known ozone depletion chemicals (ODCs) are chlorofluorocarbons (CFCs), however other ODCs include methylhalides, carbon tetrachloride, carbon tetrafluoride and halo-carbons.

In 1987 the Montreal Protocol was signed and has frequently been reviewed to ensure the phasing out of ODCs. CFCs have been banned since 1995, Halons since 1994, and Hydrobromofluorocarbons and methyl chloroform since 1996 (within the EU). HCFCs and methylbromide are currently being phased out within the EU with a total ban from 2015.

Action:

Inform all contractors who handle products containing ozone depleting chemicals of the Food and Drink Forum's Policy & ensure the tenants of the Southglade Food Park adopt this Policy
When procuring products establish the availability and appropriateness of alternatives to ozone depleting chemicals

Include policy in design briefs

Ensure correct disposal of any products that contain ODCs through a licensed waste contractor
Ensure Southglade tenants understand the importance of minimising leaks from refrigeration pipe work

Ensure that products purchased do not contain ODC. See the table below for alternatives.

Products containing Ozone-depleting chemicals & Alternative Products

1. Refrigerators, Freezers and Chillers
 1. Buy units which use propane, butane or pentane as refrigerant, and which do not contain HCFCs in the insulation
2. Building Insulation
 1. Specify types of insulation other than foam, or foam insulation which is blown without the use of HCFCs
3. Furniture Foams
 1. Buy soft furniture which uses alternative fillings such as natural fibre or latex rubber, or which uses foam blown without using HCFCs
4. Halon Portable Fire Extinguishers
 1. These are not used by the Food and Drink Forum

Car Use

Policy Aims:

1. to minimise the amount of car miles
2. encourage walking, cycling and the use of public transport as alternatives to the private car
3. Promoting the use of hybrid cars if possible

The Food and Drink Forum aims to contribute towards the reduction of the over all production of CO2 emissions and natural resources depletion, by reducing the amount of fuel used to run Food and Drink Forum employee private cars for work activity.

Action:

Ensure all staff has access to route planning software to maximise journey efficiency Ensure all staff minimise car journeys

Ensure car sharing is in operation whenever possible

Whenever possible travel at non rush hour times to maximise car efficiency

Skyping with businesses for updates and only driving when on site visits are needed

Paper**Policy Aims:**

1. to minimise paper usage
2. to maximise the use of recycled content paper
3. to purchase and use only 100% recycled non chlorine bleached white paper for general office printing
4. to specify the use of paper with 100% recycled content when printing is contracted out

The Food and Drink Forum is a substantial consumer of office paper. This policy aims to reduce this consumption and unnecessary wastage. In addition to this the policy aims to maximise the use of recycled paper.

Recycled Paper is paper that is made from recovered materials. The amount of recovered material can vary and therefore it is important to check the percentage. The type or recovered material can also vary from post consumer waste (i.e. office waste, newspapers) to pre consumer (i.e. mill off-cuts).

Chlorine Bleached Paper can be harmful to the environment as the residues produced in the bleaching process are harmful to the environment if they get into rivers or streams. Therefore non-chlorine bleached is a specification.

Coloured Paper can be sourced with a recycled content however the quality may not be suitable for use. Consider the use of recycled content where the quality can be guaranteed.

Action:

If you are ordering white paper or contracting printing specify 100% recycled content paper or paper from sustainable responsibly managed forests.

Minimise paper use by using email and storing documents electronically.

When producing a document minimise the number the number of pages needed by considering font and size, page margins and paragraph spacing.

Use both sides of the paper when photocopying.

Re use the reverse side of printed paper as scrap.

Recycle waste paper via the office waste paper collection points.

Offsetting

Carbon Offsetting is simply being responsible for your company's emissions by investing in a program that is targeted towards decreasing GHG emissions, however the key aspect of this process is to mention the program has to take place offsite of the company.

-Ex. For every box of computer paper purchased, the Food & Drink Forum would donate a certain pound amount to the African Rainforest Conservancy.

Accreditations

There are 3 accreditation levels to iE that your organisation can work towards. This means there is something appropriate for any business wishing to go green, from taking the first simple steps to understanding environmental factors, to being a truly sustainable business.

Bronze from £150 +VAT: For a basic level of accreditation, all your business has to do is to undertake an environmental impact assessment, set targets for improved energy efficiency for resources such as energy, water and raw materials, take quarterly resource readings and report more detailed progress annually. It is also a requirement to have an environmental policy in place.

Silver from £200 +VAT: This level is for a business that is looking at their environmental impact to achieve even higher cost savings. Your commitment is the same as Bronze level, with the additional requirements of showing actual targets achieved within the workplace, adopting a travel plan and undertaking two essential actions that work best for you.

Green from £300 +VAT: This is the highest achievable level within iiE. As part of the process, an onsite audit will be undertaken by iiE and your business will need to demonstrate a minimum 2% improvement in energy efficiency over an agreed baseline figure. You will be required to commit to the same standard as Bronze and Silver Level, but with 3 additional essential actions. You should also calculate your carbon footprint and set targets for reduction.

Communication

Monitoring and Progress

- In efforts to reduce GHG emissions, as previously stated, persons should be installed into positions where they are responsible for monitoring not only usage, costs associated to usage, but changes within the various sources between the baseline and the upcoming year.

Ex.

- The meter reader will observe changes in usage throughout the year, recording readings monthly.
(May be necessary to acquire a smart meter, which digitally keeps track of usage and costs.)

<http://www.britishgas.co.uk/smarter-living/control-energy/smart-meters/what-are-smart-meters.html>

Communication Internally

- Company will embed the environmental policy into the culture of the organization.
 - Staff will become well versed on what it means to be sustainable and how it pertains to the Food and Drink Forum

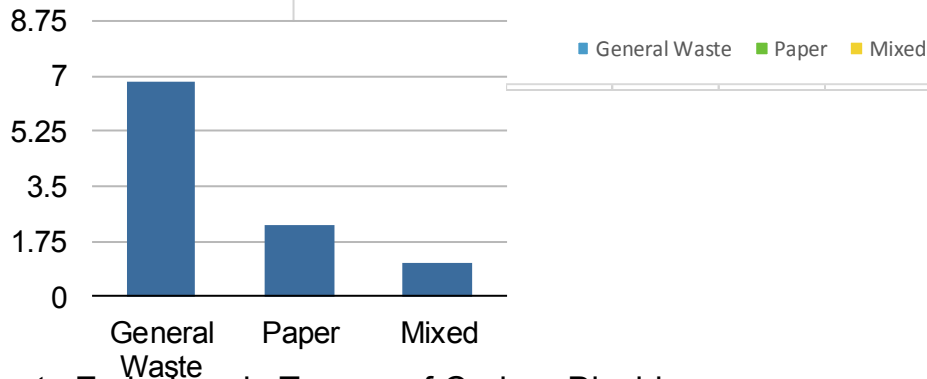
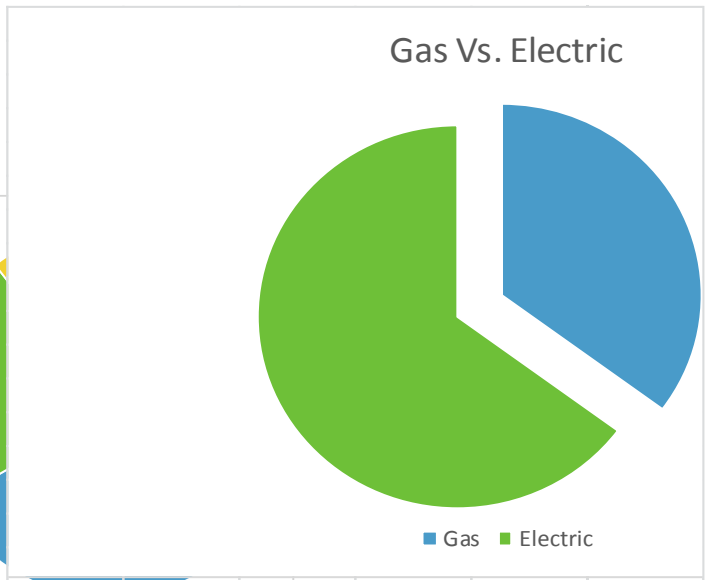
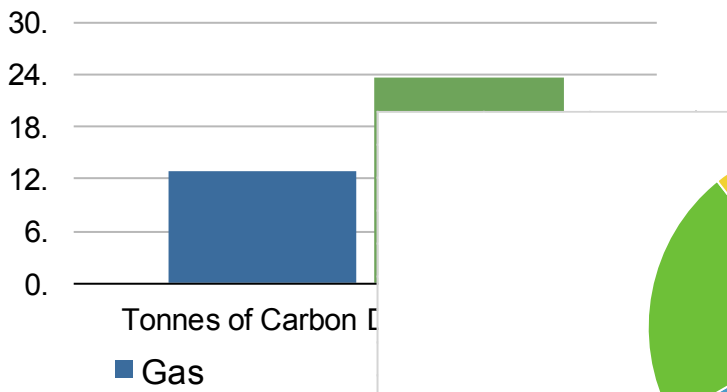
- Monthly meetings regarding understanding of the environmental policy and their perspective roles.
- When progress is reached or when policy is fully adapted, meetings may become fewer.
- Staff will also receive updates regarding the results of their actions, such as; stating the reduction in energy costs by shutting off light.

Communication Externally

- The Food and Drink Forum will communicate extensively with clients and members regarding the benefits of sustainability.
 - Staff will provide clients with knowledge concerning what actions to pursue to become environmentally efficient.
 - Suggest making changes in supply chain.
 - Suggest making changes in cookware and appliances. (Are they certified energy savers.)
 - What to do with food waste?
 - Are they utilizing the 3 R's? (Reduce, Reuses, Recycle)

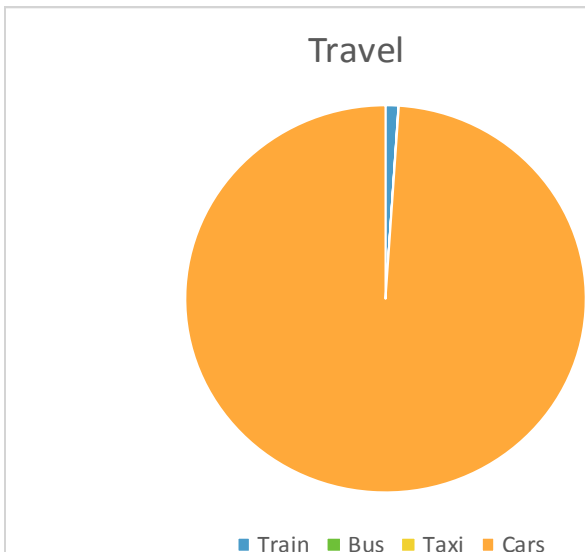
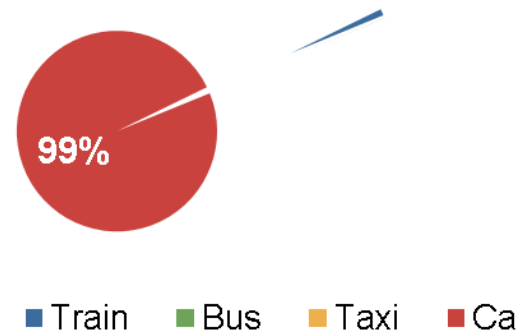
Appendix

Gas vs. Electric Emissions



Waste Emissions in Tonnes of Carbon Dioxide

Transportation Emissions



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<http://www.statelineeco.com/resources-eco-education/lighting-basics/led-watt-conversion-table-light-types-guide.html>
<http://www.foodanddrinkforum.co.uk/web/xfdf/more-about-the-forum.cfm>
<http://www.britishgas.co.uk/smarter-living/control-energy/smart-meters/what-are-smart-meters.html>

WILL BITCOIN CHANGE THE WAY WE DO BUSINESS?

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ABSTRACT

Bitcoin is a digital currency that is not backed by any government or bank. Anyone can download the bitcoin source code and mine bitcoins. Bitcoins are gaining value as more organizations and individuals have started to accept them. Most businesses that accept bitcoins are e-commerce; however, a small but growing number of “brick-and-mortar” businesses are also starting to accept this digital currency. This research paper evaluates the advantages and risks associated with the usage of bitcoins. They have a lower transaction cost and cannot be reversed like credit card transactions. One of the major risks associated with bitcoins is the exchange rate fluctuation. Bitcoin is one of the most successful cryptocurrencies so far. Building upon the advantages and associated risks involved in bitcoin usage, this paper strives to answer whether bitcoins will change the way individuals and organizations conduct business.

INTRODUCTION

Will bitcoin change the world? Or at least, will it change the way we do business? Is bitcoin just a fad? Or is it the greatest electronic invention since the computer microchip? Bitcoin is a digital currency. Its origins are shrouded in secrecy. It was invented in 2009. Except for the person (or people) who created it, no one knows who the actual inventor is. Bitcoin’s creation is credited to Satoshi Nakamoto. Who is Satoshi Nakamoto? No one knows. Satoshi Nakamoto could be a single individual or a group of individuals. What is a bitcoin? Again, the answer is not that simple. Bitcoin with a capital “B” refers to the network protocol while lowercase “bitcoin” refers to a unit of currency. (Marshall, 2014, p.30)

Bitcoin is a cryptocurrency. A cryptocurrency is digital currency that uses cryptography for security and anti-fraud procedures. (“What is Cryptocurrency?,” n.d.) Bitcoins have a string of alphanumeric markers that lists the history of each bitcoin so that the Bitcoin network can authenticate the validity of each transaction and change the bitcoins’ ownership from one user to another.

Bitcoins are very different from yet also similar to fiat currency. Fiat currency is regular money. It is money that a government has declared to be legal tender. However, fiat currency is not backed by a physical commodity. Its value is not because of the material it is made from. In, what some might call the “good ol’ days”; most currencies were based on physical commodities like silver and gold. Since fiat currency is not backed by a physical commodity, how does it have value? Fiat currency has value because the people who use it believe it has value. Bitcoins are not backed by any government or bank. It has been said that the only reason bitcoins have value is because people choose to believe they are valuable (Van Alstyne, 2014).

To some, one of the reasons bitcoin has an advantage over fiat currency is because it can be moved anonymously from one country to another (Turpin, 2013). However, this anonymity is

not entirely true. Every bitcoin transaction must be authenticated by the Bitcoin network. A transaction cannot be anonymous if someone has to verify it. Turpin (2013) used the following analogy to describe a bitcoin transaction:

A [bitcoin] user's wallet consists of the bitcoins it contains, a public key, and a private key. The public key is the address to which another party can send bitcoins, and the private key is what enables the wallet's owner to send his own bitcoins to someone else. As an analogy, the public key is your street address, and the private key is the key to your front door; others can send mail to your house with no more than your address, but no one can remove your belongings without your permission. (p. 337-338)

The bitcoin source code is available online and anyone can download it. Bitcoins can be created or "mined" by solving complex math problems. One author compared bitcoins to the "Wild, Wild West." It is easy to see why. Even though bitcoins are purely digital currency, the visual representation of a bitcoin is a gold coin. The term used to create bitcoins is "mining". This is what prospectors did during the California Gold Rush in 1849. Because the bitcoin market is unregulated, there has been a "modern gold rush" to acquire the currency (Sharf, 2014).

A bitcoin was worth almost nothing in 2010. It was worth about \$1 in April 2011. In 2013, one bitcoin was worth approximately \$1,000. In February 2014, it was worth \$550 (Van Alstyne, 2014). There are several reasons for this wildly fluctuating variation in the price of a bitcoin. One reason is because of the number of people who currently own any amount of bitcoins. According to Mark Williams, a finance professor at Boston University, the price of bitcoin has been determined by just a few people. He states that "forty-seven people own 29% of all outstanding bitcoins; 930 people own 50%. There are about 10,000 people who bring the total owned by the largest coin holders to roughly 75%, leaving a sliver to be split among about 1 million small-change bitcoiners." (Sharf, 2014). These numbers make it seem that if people are not already mining bitcoins, they are "behind the curve" and will never be able to catch up with the early adopters. According to Satoshi Nakamoto there can only be 21 million bitcoins. Bitcoin will reach 21 million in 2140. After that time, it will be impossible to create or "mine" more.

Even with all of the fluctuations in price and lopsided ownership, the main consensus seems to be that Bitcoin is a brilliant idea and will change the way business is done forever. The question is, is this cryptocurrency strong enough, valuable enough, desired enough and smart enough to be a viable alternative to regular money? Is bitcoin something that today's business manager needs to consider? Is it possible that bitcoin will explode, metaphorically speaking, and become more valuable than any physical commodity, like silver and gold? Should business managers start preparing to pay their employees in bitcoins? This paper will present a balanced approach to bitcoin and look at it from all angles. The goal is to provide a detailed account of all sides of the creation, use, value and controversy surrounding bitcoin.

LITERATURE REVIEW

Bitcoin is not the first attempt at virtual currency. Cryptographers, people who encipher and decipher messages, have been trying to create a reliable digital currency for decades. A few of the examples are: Ecash, bit gold, RPOW, and b-money (Wallace, 2011). Each one failed miserably. One of the main issues with the other forms of digital currency is the double spending

problem. Double spending happens when a user spends the same money more than once. This is easy to do with digital currency because all a user has to do is copy and paste the same digital information multiple times. Without a third party to authenticate each transaction, fraud would be rampant. The creator (or creators) of Bitcoin attempted to fix this problem with something called a “block chain”.

In his 2011 article entitled “The Rise and Fall of Bitcoin” Benjamin Wallace, a journalist with Wired Magazine, describes how bitcoins are mined. Miners are the people who let their computers run “a special piece of software” and they form a third party network, called a block chain. The block chain authenticates each bitcoin transaction. This authentication process stops the same money from being spent more than once. The block chain also generates new bitcoins. Bitcoin transactions are sent to the block chain and the miners’ computers compete to solve the extremely complex math problems. The first miner to solve each problem is paid 50 bitcoins. That transaction is then sent to the block chain. Each time the number of miners increase, the math problems get harder to solve. In addition to that, each time 210,000 transaction “blocks” are solved, the amount of bitcoins awarded decrease by half. Eventually, miners will get 25 bitcoins for solving the transactions, then 12.5 bitcoins, then 6.25 bitcoins and so on. As stated earlier, only 21 million bitcoins will ever be created and that limit will be reached by 2140.

Satoshi Nakamoto set up the mining of bitcoins this way for several reasons. At a time when the banking system was on the verge of collapsing, the euro was in crisis and quantitative easing was being used to stimulate the economy, Nakamoto wanted his bitcoins to enter the market in a “predetermined, knowable rate” (Turpin, 2013). He wanted to make sure that no individual or entity could flood the market with his new currency. He was very clear that his desire was for bitcoin to grow slowly yet steadily.

In November 1, 2008, he posted a research paper to a little known cryptography listserv describing Bitcoin. He mined the first 50 bitcoins on January 3, 2009. When those excited about the possibility of bitcoins began demanding the use of bitcoins for everyday activities almost exclusively, Nakamoto posted a message on his bitcoin forum that it would be best if bitcoin grew slowly. As bitcoins began to get more and more popular, Nakamoto withdrew from the public eye. He posted his last message on December 12, 2010. This message only dealt with the intricacies of the latest version of the bitcoin software. Before disappearing, one of the main issues Nakamoto relayed to others was his distrust of banks and the way governments handle money. Those wary of bitcoin consider his talk of distrust a laughable premise. Bitcoin is very new and primarily virtual. There are many who cannot see how bitcoins will ever be fully trusted without being backed by some regulations.

The lack of regulation is what draws some people to bitcoin. Silk Road and Mt. Gox are prime examples of the dangers of unregulated currency. Silk Road was a website that sold illegal drugs. Heroin, methamphetamines, crack, cocaine, LSD, ecstasy, etc. could all be bought on Silk Road and the currency of choice was bitcoin. (Greenberg, 2013). The people who used Silk Road used bitcoins because of the perceived anonymity. All bitcoin transactions have to be verified so it is possible to trace a bitcoin back to a particular person; however, the process is long and difficult. The FBI shut down Silk Road in October 2013 but it did not take long for Silk Road 2.0 to pop up. Mt. Gox also hurt bitcoin’s reputation. Mt. Gox was originally a Tokyo game card trading

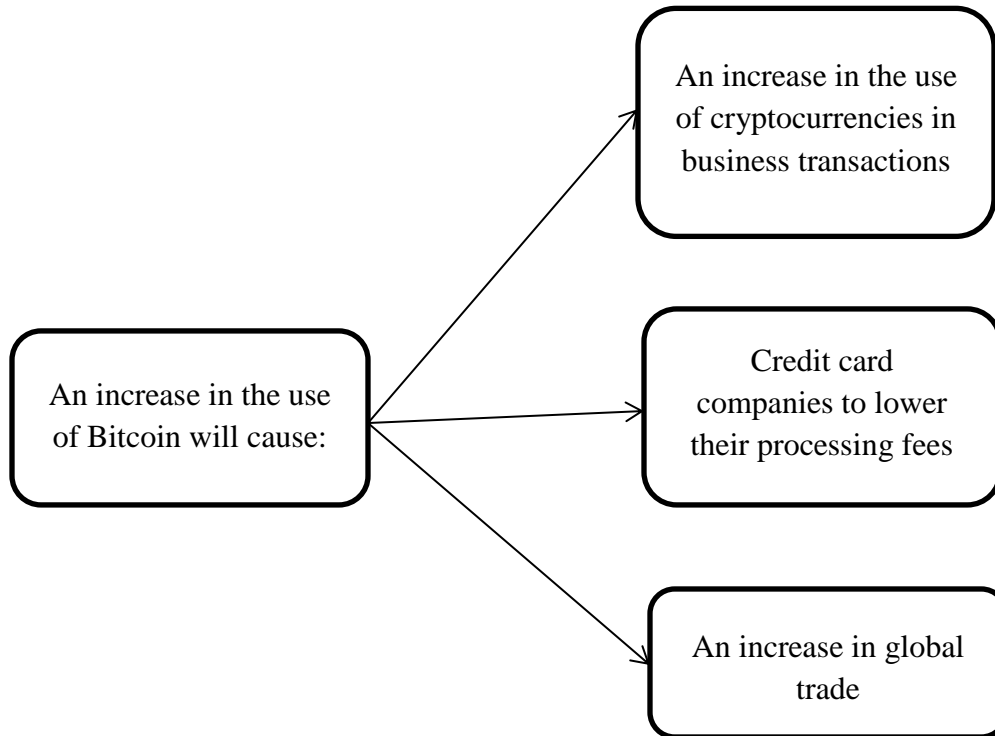
site and became a bitcoin exchange. A hacker was able to steal tens of thousands of other people's bitcoins, worth approximately \$350 million. (Van Alstyne, 2014). Even with bitcoin's bad press, Donald Normand, a bitcoin enthusiast who setup a bitcoin exchange, believes that trusting in bitcoin is easy. The reason for his trust is that the bitcoin currency itself "has never been cracked or compromised." (Evans-Pughe, 2012).

People liken their trust in bitcoin to their trust in other fiat currencies, like the dollar, the yen, or the euro. Traditional currencies are not valuable because of the material they are made of. They are valuable because people choose to believe in them. According to Ursula Huws, professor of Labor and Globalization at the University of Hertfordshire, if people stop believing in fiat currencies, they "collapse." (Evans-Pughe, 2012). As an example of people losing trust in fiat currency, in 1921 the deutsche marks of the Weimar Republic of Germany were "relatively" stable at approximately 60 marks per US dollar. By the end of 1923, 1 US dollar was worth 1 trillion German marks (Goodman, n.d.). A similar thing happened in Zimbabwe in 2009 when, because of inflation, a 100-trillion dollar bill could not even buy a bus ticket (Mutsaka, 2011). The United States is also not immune to money troubles. Even though fiat currency is backed by banks and governments, there is still the potential to get around the regulations. People avoid paying their taxes and others launder money.

According to David Birch, the director of a British consultancy group, using virtual currency will lead to a "frictionless global means of exchange" that could, in turn, "stimulate a new era of trade." (Evans-Pughe, 2012). But even with the way that bitcoins could help with globalization, Birch still feels that there should be some regulation in order to protect the consumers. The conundrum is that the absence of regulation is why bitcoins were created.

CONCEPTUAL MODEL/Framework

Figure 1



According to Greene and Shy in their article “E-cash and Virtual Currency as Alternative Payment Methods” in 2012 almost 50 percent of consumers made their payments with cash. Young adults, those between the ages of 18 – 24, used cash the most. Cash accounted for 47 percent of their transactions (Greene & Shy, 2014). There is a reason why cash is a popular alternative to other forms of payment: It is accepted almost everywhere, it is convenient and costs to use it are low.

Even today, when bill paying, shopping and person-to-person transactions can be done online, cash is still king. A March 21, 2014 article in the Wall Street Journal summarizes the benefits of using cash in a techno friendly world like this:

Dollar bills can be stolen, of course. But they can't be stolen online. Their use doesn't leave an open door to your bank account for a hacker to walk through. They are hack-proof, anonymous, and lighter and more durable than a smartphone. (Arends, 2014).

In a March 14, 2014 article in The Augusta Journal, an interview was conducted with David Capps, a small business owner who only accepts cash and checks. He does not accept credit cards because he does not want to pay the processing fees. Financial institutions charge merchants around 3 percent per purchase and Capps would have to raise his prices in order to make a profit (Martin, 2014).

There are disadvantages to using cash though. According to the Boston Feds Survey of Consumer Payment Choice, almost 10 percent of U.S. consumers had experienced “theft of cash” averaging \$300 during 2012 (Greene & Shy, 2014). The banking crisis in the United States and abroad was also a great cause for concern. In the Mediterranean, the bank of Cyprus loaned more money than it had to give and decided to take 6% - 10% from everyone's savings account. Naturally, the people panicked and started withdrawing their money from the bank. To keep too much money from leaving, the bank put armed guards in the bank and restricted the amount that could be withdrawn daily (Goldman, 2013). Consumers everywhere began to realize that their money may not be as safe as they thought or hoped. In some ways and for some people, digital money provided a more convenient and possibly safer substitute.

According to Turpin (2013), in theory, at least, bitcoins should be extremely attractive to merchants. One of the reasons is because there are little to no transaction fees. Transaction fees are big business for credit card companies and banks. There are four groups involved with every credit card transaction: the merchant receiving the payment, the bank that the merchant uses to provide processing services, the bank that issued the card to the customer, and the customer. (Downs, n.d.) The Journal of Economic Surveys reported that in 2006, Visa and Mastercard received more than \$30 billion in transaction fees (Verdier, 2011).

What are these transaction fees, also known as interchange fees? One of the fees is called a rate or a discount rate. This is based on the amount of the transaction. The other part of the transaction fee is split to several different categories. There are authorization fees, return fees, AVS fees, gateway fees, etc. According to Verdier, banks say that interchange fees are necessary to encourage consumers to use credit cards instead of cash. Merchants, however, say that interchange fees increase the cost of accepting credit cards.

As stated earlier, merchants who accept credit cards have to pay about 3 percent per purchase and some feel like that is too high. Small business owners, especially those who do not have a very high sales volume, would have to raise their prices to help cover the cost of the extra fees. Merchants also have to pay a swipe fee. According to the National Retail Federation, credit card swipe fees have tripled in the past 10 years. This is one of the reasons why 55 percent of the 27 million small businesses across the United States did not accept credit cards in 2012. (Martin, 2014).

Bitcoins, on the other hand, have little to no transaction fees. BitPay, a bitcoin payment processing service provider, used to charge 0.99 percent to process payments. In 2014, they announced that they would process bitcoin payments for free (Sakich, 2014). There are several ways customers can pay with bitcoins once they find a business that accepts them. If the business has a bitcoin wallet, the customer would send a test message to the person who manages the store's wallet. The customer would receive a reply with the store's wallet address. The store's cashiers would then ring up the transactions on a POS terminal as a check ("A Small Business Takes To Bitcoin Payments.," 2014).

In addition to low transaction fees, bitcoin transactions are irreversible so merchants do not have to worry about the dreaded "chargebacks". A chargeback is money that is taken back by a credit card company for its cardholder. The money can be taken back because of fraud or lack of good business practice by a merchant. According to a 2009 LexisNexis "True Cost of Fraud Study", merchants are paying \$100 billion in fraud losses due to unauthorized transactions and the fees and interest associated with chargebacks ("Credit Card Disputes and You," n.d.). Bitcoin does not allow chargebacks. Bitcoin (the network) believes that bitcoin holders have total ownership rights over their money and as such, should only send money to trusted entities ("Myths - Bitcoin," 2014). Therefore, all sales made with bitcoins are final. Since bitcoins offer so many benefits to merchants, credit card companies would have to lower their processing and transaction fees in order to keep their merchant customers from switching to Bitcoin exclusively. Although it would take a while for a "brick-and-mortar" business to use bitcoins exclusively, e-commerce sites could move in that direction much more quickly.

In Jonathan Turpin's article, "Bitcoin: The Economic Case for a Global, Virtual Currency Operating in an Unexplored Legal Framework" he mentions that bitcoins would be especially useful to people in developing nations. Because the government backed currencies in some countries are unstable, some people have decided to use bitcoins instead. Access to a bank, especially to a reputable one, can be sparse in some developing countries. The infrastructure may be underdeveloped. Traditional banking services may not be available. Savvy individuals can find a way around this by using their mobile network. In 2013, the United Nations released a report that of the world's 7 billion people, 6 billion people have access to a cell phone. Only 4.5 billion have access to a working toilet (Wang, 2013).

Kenya is a prime example of a developing country that uses bitcoins. In a place where banks are "unpredictable" and credit card use is spotty, Kenya is the world leader in mobile payments (Bartlett, 2014). People can send bitcoins to BitPesa, a bitcoin payment processing system, similar to BitPay. BitPesa converts the bitcoins into the local currency then sends it to the mobile

phone of the recipient. That person can use the money to pay for products or cash it out. They can use bitcoins to manage not only their business but their other financial needs, as well.

As mentioned earlier, David Birch feels like Bitcoin could “stimulate a new era of trade”. His consultancy group worked on the mobile phone-based money transfer system (M-PESA) that is used in Kenya. He said that this is the age of e-books and blogs but there are still problems paying for them. He feels like Bitcoin would be a solution to several problems. Says Birch (2012):

If there was a red button on your keyboard that said give this person 50p, you can imagine new businesses springing up. Because M-PESA provides a simple low-cost way of paying people, there are businesses in Kenya that could not have existed before. Firms can now sell a day’s insurance, for instance, to farmers who need to move their animals from one place to another. (p. 60)

WordPress, one of the most popular blog publishing sites in the world, hosts 60 million blogs in 120 different countries. CNN and The New York Times are two of the most well-known news sites that use WordPress. WordPress accepts bitcoins. Some of the countries who use WordPress do not even accept PayPal. However, the use of bitcoins makes it a lot easier for bloggers in those countries to fund their websites (Turpin, 2013). People in developing countries could start their own businesses and send and receive payments using bitcoins and never have to step foot in a traditional bank. However, circling back to a point that was mentioned earlier, switching to bitcoin exclusively cannot be done until the risks are also assessed.

On any “pros and cons” list about bitcoins, one of the major cons is the exchange rate volatility. Bitcoin’s value can fluctuate as much as 40 percent in a 24 hour period (Turpin, 2013). Greene and Shy believe that the fluctuations are a good thing. The wildly varying rates are a consequence of the growing demand for bitcoins (Greene & Shy, 2014). The exchange rate fluctuates because a small number of Bitcoin traders have large value transactions. The fluctuations will decrease as more people use the currency for small value transactions. Turpin believes that there is a way that businesses could still benefit from using bitcoins, even with the fluctuations. Turpin’s suggestion is that since merchants accept other forms of currency besides bitcoins, they could peg the price of their goods and services to other currencies and then accept bitcoins at a fluctuating rate (Turpin, 2013). This is similar to what some smaller countries do when they peg their currency to another country’s currency. The countries that depend more heavily on international trade buy and sell its own currency on the foreign exchange market in order to balance supply and demand (“Pegged Exchange Rate Definition & Example | Investing Answers,” n.d.).

Another con for Bitcoin and another reason more merchants are hesitant to use bitcoins is because there are still many questions about its legality. Turpin (2013) believes that Bitcoin operates in a “legal grey area”. The Department of the Treasury Financial Crimes Enforcement Network (FinCEN) supplied some regulation on virtual currencies in March 2013. They ruled that:

Ordinary users of virtual currencies are not subject to regulation, just as ordinary users of cash are not. However, exchanges and miners who sell their bitcoins are defined as

money services businesses, and both are subject to regulation as money transmitters. Exchanges are subject to the same regulations as ordinary currency exchanges. (p. 365)

Since bitcoin is such a new technology, very few countries have laws that are specific to digital currency.

CONCLUSION

Managers have a lot to consider if they choose to accept bitcoins. Because the technology is still very new, it will scare off some people. The bitcoin reputation has been hurt by people who have done bad things with the currency. Some have used bitcoins to purchase illegal products. Some have stolen millions of dollars' worth of bitcoins due to lax security measures. Some people have lost their bitcoins simply because they forgot their password to their bitcoin wallets. Bitcoin's supporters say that bitcoin should not be judged "guilty by association". They feel that just because some people have chosen to do bad things does not mean that the currency itself is bad. For those concerned about the "newness" of bitcoin and the technology that surrounds bitcoins, the supporters point out that PayPal did not exist before the creation of the Internet, and now, most people feel comfortable using PayPal for online transactions.

Another risk that managers will have to consider when using bitcoin is the exchange rate fluctuation. As long as the price of a bitcoin varies wildly from one day to the next, there will be a risk to accept bitcoins as payment. It will take time and a multitude of people using bitcoins for smaller transactions to bring the exchange rate under control. Some of bitcoin's biggest critics are former Federal Reserve chairman, Alan Greenspan (Soder, 2014), and well known billionaire Warren Buffet (Kutler, 2014). Greenspan feels that bitcoin is just a fad and Buffet feels that bitcoin does not meet the definition of currency and will not last another 10-20 years.

Bitcoin has famous supporters as well. The Winklevoss twins (of Facebook fame) and Richard Branson, who is also a billionaire, were early supporters of bitcoin (Soder, 2014). Those excited about bitcoin see it as more than just an investment opportunity. There are a lot less fees associated with bitcoins. The processing fees are practically nonexistent and there are no swipe fees or chargebacks. Because bitcoins can be divided to eight decimal places, micropayments are possible. Turpin believes that the ability to make micropayments will be particularly helpful to those in developing countries because they will not have use a traditional bank in order to conduct their business. (Turpin, 2013)

The number of businesses that accept bitcoin is growing. A few of the more well-known businesses that accept bitcoins are Overstock.com, 1-800-Flowers, Tesla Motors (an electric car maker) and Virgin Galactic, one of Richard Branson's startups. There is even a company in Hong Kong working on a bitcoin debit card. ("Bitcoin goes plastic,," 2014) It is indeed possible that bitcoin could change the way business is conducted. Barriers to trade are lowered because bitcoin can move across borders with relative ease. Those in developing countries do not have to rely on a bank to send or receive money. Because of the lower processing and transaction fees associated with bitcoin, credit card companies will have to make changes to the way they deal with merchants. They stand to lose billions of dollars a year if their merchant customers chose to accept bitcoins, rather than credit cards. Bitcoins are moving from e-commerce sites to more

“brick-and-mortar” businesses. There are many bitcoin websites where users can enter their zip codes and find places near them that accept their new cryptocurrency. They can buy a cup of coffee at The Pao Café in New Hampshire. (“Use Bitcoins in the real world,” n.d.). Bitcoins users can buy a slice of pizza at Roma Pizza in Bloomingdale, Georgia (“We are now accepting Bitcoin in our family-run New York style pizza joint in Savannah, GA! • /r/Bitcoin,” n.d.), or users can swing by one of REEDS Jewelers’ 64 locations and pay for their purchase with bitcoins. (“What can you buy with bitcoins?,” n.d.).

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Minimizing the Risks of ERP Implementation Challenges: A Case Study

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Abstract

Enterprise Resource Planning (ERP) systems have become increasingly popular in recent years among businesses in the United States and around the world. Corporations have much to gain by implementing ERP systems. However, if ERP implementation mistakes are made, the company can face huge losses including down-time as well as more direct financial losses. Avoiding these mistakes can help companies maintain the level of performance they need during implementation without disrupting the business. ERP system implementations are a significant investment of money, time, and resources for organizations. These implementations vary from “traditional” IT-related projects because they often affect an entire organization. Therefore, it is imperative to minimize the risks related to such a large project. This study identifies common challenges affecting the successful implementation of ERP systems in published research to date and provides a case study that follows the ERP implementation of a large industrial manufacturing organization in the southeast. The challenges most often faced by business are compliance issues during transition; lack of proper training; the high cost of implementation; lack of support and/or communication from senior management; and employee unwillingness to adapt. This paper with its supporting case study shows how these challenges can be minimized.

Introduction

Enterprise Resource Planning (ERP) systems are integrated software solutions providing standard business functionality. These systems allow key information such as accounting, human resources, procurement, and inventory to be accessed across an organization enhancing the flow of information. The major ERP suppliers are SAP, PeopleSoft, which is owned by Oracle, and Oracle (Senft & Gallegos, 2009). Before the wide-spread use of ERP systems, companies often used standalone systems for each function of their organization. These standalone systems often did not communicate effectively across

the organization. In 2000, Nike paid dearly for poor communication among business processes by producing too many of the wrong shoe and not enough of the correct ones. This communication error cost the company more than \$100 million in the quarter the error occurred and resulted in a drop in share price (Magal & Word, 2010). One of the main benefits of ERP systems is the ability to communicate across-functions using an integrated system.

When implemented properly, ERP systems provide many benefits to organizations. Not all ERP implementations go as planned and some even result in failure. According to Wailgum (2009), the companies that have seen huge failures and large financial losses during ERP implementation include Hershey, Nike, HP, and the University of Massachusetts.

The cost involved in ERP system implementations is significant. Often several years of time and resources are involved in the implementation. The effects of a failure can be devastating to a company. Unisource Worldwide, Inc. wrote off \$168 million in costs related to an SAP implementation that they scrapped. Unisource was four years into the implementation before deciding it was not the right choice for their organization (Stein, 1998). FoxMeyer Drug filed a \$500 million lawsuit against SAP and filed for bankruptcy in 1996. FoxMeyer claims that their SAP implementation led them to bankruptcy (Bingi, Sharma, and Godla, 1999). The list continues for companies that have unsuccessfully attempted to implement an ERP system. It is estimated that 90% of SAP R/3 projects run late according to the Standish Group International (Scott and Vessey, 2002). It is important for companies to be aware of the factors that often lead to failure so that they can prevent them. The objective of this research is to identify common ERP implementation pitfalls and how they can be avoided in future implementations.

Literature Review

High Cost of Implementation

The cost and time involved in ERP implementations is often under-budgeted. According to a recent report, the average cost of ERP implementation over the past 4 years has been \$7.3 million dollars (Panorama Consulting, 2013). The average duration of ERP implementation has been 16.6 months. The length of time to implement increased from 16 months in 2011 to 17.8 months in 2012. Respondents also indicated that 59% of the ERP implementations exceeded their budget and 53% exceeded their planned implementation timeline. These high costs of implementation and history of overages put a dark cloud over the thought of ERP implementation.

As demonstrated in the abovementioned report, organizations often under-budget for an ERP implementation in both time and resources. While it is common for implementations to have unexpected costs, it is necessary to budget for them properly from the beginning in both time and money. Unrealistic timelines that do not have contingencies built in, and these being subjected to frequent review and assessment, set an organization up for failure. Effective planning for implementation milestones and the management of them is critical to an implementation that stays on-time (Protiviti, 2012). One effective tool in gaining the proper resources necessary for a successful implementation is support from senior management.

Lack of Support/Communication from Senior Management

ERP systems are usually implemented within companies to improve the flow of information throughout the organization. The improved communication provides more beneficial information to the decision-makers within the company. Due to the resources involved, it is imperative that top management supports the project and be committed to its success every step of the way. However, one of the main

reasons for ERP failure is the lack of support and communication by senior management (Ligus, 2004). ERP implementations cannot be viewed as simply an “IT project” and handed off to the IT department by upper management. ERP implementations require that the entire company be on board from the top down (Bingi, Sharma, and Godla, 1999). Research shows that this lack of management support during ERP implementation was a factor in the demise of FoxMeyer. FoxMeyer had an implementation leader but did not appear to have the proper support in place along with him (Scott and Vessey, 2002.)

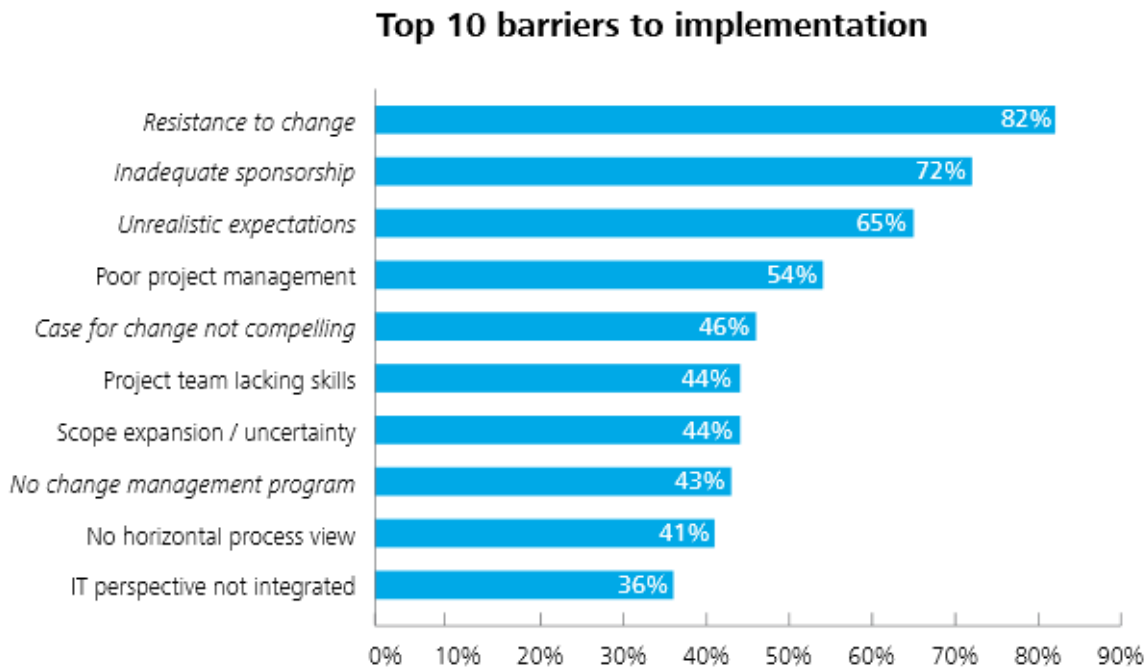
ERP implementations should not only have a project champion but a steering committee as well. This steering committee should be comprised of senior leaders from each area of the business affected by the implementation according to the risk and business consulting firm Protiviti, (Protiviti, 2012). The members of the steering committee should be provided regular updates by the project team and notified of any problems encountered. A formal decision-making process that includes top leadership will aid the process and allow the implementation to flow better.

Executive buy-in during an ERP implementation is also necessary due to the significant costs involved. When senior management is involved and supports the implementation it is easier to get the correct people on board. Implementations need proper talent from the beginning in order to be successful. Upper management support aids in the ability to secure this talent. The tone at the top of an organization will resonate throughout the company and aid employee willingness to adapt.

Employee Unwillingness to Adapt

Executive buy-in during an ERP implementation is important but it is also critical to make sure the entire organization understands the project and reasoning behind it. Management will need to “define the need for change” and show how this change will better the organization. Communicating the need for change and the benefits it will bring is an important step in gaining employee support (Deloitte and Touche, LLP n.d.). The figure below shows the top 10 barriers to implementation as found by a Deloitte

CIO Survey. As can be seen, most of these barriers are related to people with the largest challenge being resistance to change.



Source: Deloitte Touche Tohmatsu CIO Survey

This would indicate that more an ERP implementation is communicated throughout the company in a good light, the more willing employees will be to adapt. Often the unwillingness to adapt in employees is due to the fear of the ERP system replacing them. Employees are scared that technology will replace them. Communicating why the implementation is necessary and the risk of what happens if the organization does not adapt is an integral part of getting everyone on board and a successful implementation. Employees will also be more willing to adapt to an ERP implementation if properly trained.

Lack of Proper Training

Training employees on a new ERP system is a major challenge. It involves a significant amount of time which takes away from their ability to perform their normal day-to-day functions. ERP training is unlike other application training due to the enormity of the project. Often an ERP implementation can change every aspect of an employee's job. In addition to learning a new system they will also be learning an entirely new way of performing their role. Spending the time and resources necessary to properly train employees is a critical success factor to an ERP implementation. According to Eric Kaas, Vice President of Product Management for Mid-Market ERP products at Sage, "A lack of proper training is one of the most common reasons that ERP projects fail, and it can also result in employees resenting the new system because they don't understand it" (Schiff, 2012). Proper training will increase employee morale and ensure that the business continues to run smoothly. Additionally, by ensuring that employees are trained properly, the risk of non-compliance with Sarbanes Oxley type legislation will be lessened.

Compliance Issues during Transition

Although compliance issues during ERP are a very serious issue, compliance is usually an afterthought in an ERP implementation. ERP implementations often require that a company make significant changes to its existing internal control procedures. Transitioning to an ERP system usually changes where the control procedures take place. This could mean that key controls in an organization are no longer being performed effectively. According to KPMG, organizations are usually more worried about the "go-live" date of an implementation rather than getting key controls right (KPMG, 2006). Organizations need to realize that control integration is vital in ERP implementation. Even though an organization may be successful in their ERP implementation, they could fail an audit due to controls not being properly addressed.

Case Study

For this study research was conducted in a large industrial manufacturing organization in the southeast that is currently undergoing a five-year ERP implementation. This organization is currently in the preparation and planning phase of phase 3 of 6 of their implementation. Many aspect of the implementation have been successful but there have been pitfalls along the way as well. The organization has taken a pro-active step in their implementation by hiring an outside organization to conduct interviews and surveys regarding the implementation. The information provided by the outside company will allow the organization to make the changes necessary in the next phase of the implementation to ensure its success. There were 64 interviews conducted across many levels and areas of the organization. In addition, over 600 surveys were returned. There were four key themes that became evident through the use of these interviews and surveys. The key themes for the organization needs to focus on to ensure successful implementation in future phases are culture, business readiness, system readiness, and program governance. The organization took these key themes into consideration and has processes in place to ensure success in later phases of the implementation. For the most part, the themes above coincide with the issues of ERP implementation found in research today.

Culture

The research reported here has indicated that the culture of an organization is very important during an ERP implementation as is evident is current research. The surveys and interviews conducted pointed out the root causes for culture changes that need to occur as shown below:

1. Silo process focus – There was not enough focus on end to end processes and how the full organization would be impacted.
2. Fear of raising risks and issues

3. Focus on on-time implementation rather than quality
4. Focus on meeting deadlines rather than user readiness
5. Trying to re-create legacy environments versus standard process transformation

In response to the above findings, the organization has defined a plan to minimize these risks in the future. The culture of an organization also has to allow for people to identify risks without fear.

Allowing these risks to be communicated freely will only help the organization in the long run and support a successful implementation. One of the biggest lessons learned is that end-to-end processes need to be fully understood before a phase of implementation occurs. Different departments in an organization often have a silo mentality but it is important to view an entire process from beginning to end when undertaking an ERP implementation. Understanding the business and the culture of an organization has been underlined as very important success factors in ERP implementation.

Business Readiness

It has been established that the culture of an organization and support from leadership are important success factors to an ERP implementation. However, the business as a whole has to also be prepared for the change in order to be successful. The findings in relation to business readiness are shown below:

1. Lack of understanding of current state business processes
2. Risk management process failed to accurately identify, escalate, and manage risks
3. Business resources were balancing project work in addition to daily responsibilities

Understanding the current state of the business before implementing change is vital. This organization learned that even though they believed they had a good handle on the current state of the business that once the implementation began there were areas that were lacking. Additional time and effort has now been added to the beginning of each phase in order to properly document the as-is state of the

business. This as-is state will then be compared to the future state of the business once implementation has occurred. Once the as-is state of the business is established, processes can be aligned and system gaps identified. Defining the as-is state of the business will also help to align and gather the necessary personnel resources for the implementation. Once the business is prepared for implementation, it is also necessary to ensure system readiness.

System Readiness

System readiness or lack thereof can decide the difference between a successful implementation and a failure. The first two phases of implementation revealed that the testing plan was not designed with the appropriate level of detail. Implementation readiness needs to be tested at the same volumes that the system will face during normal business usage. While volume testing was performed throughout the organization and all phases of the implementation, it was soon realized that the volume of transactions processed did not come close to the volume faced once the implementation went live. This was a key learning lesson for future phases of implementation. Once one phase of implementation was complete and performing their go-live testing, another planning phase of the implementation had already begun. By the time the organization learned of areas that did not perform as planned, it was too late to implement the corrective actions needed before the next phase of the implementation was started. This failure caused workarounds to be created instead of the root cause of the problem being addressed. The organization is aware of these challenges and has developed an improvement plan to prevent these actions from happening again. Below is the solution plan identified in order to prevent these actions from occurring in future phases of the implementation:

1. Perform independent, third-party verification of testing results
2. Implement business-led solution sessions
3. Testing readiness needs to be approved by the proper sources

The addition of business-led solution sessions will lessen the workarounds that are created and force the root causes to be identified. The creation of workarounds in an ERP system is not much better than when organizations used legacy systems. Often the system has the capability of what the user created a workaround for, the awareness just is not there. Although these complications did cause significant problems during the go-live phase of implementation for this manufacturing facility, it did not ultimately result in failure of the implementation and the organization was able to avoid significant financial loss.

Program Governance

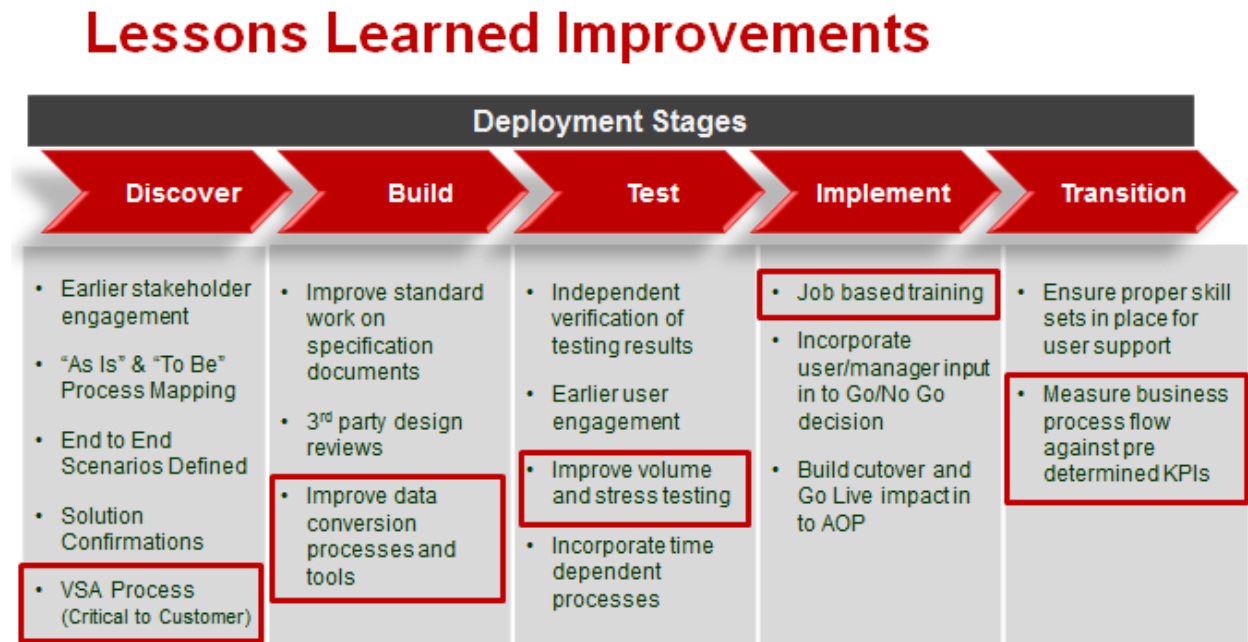
Program governance is a critical element to any project since it provides the decision-making framework. One of the largest challenges faced by the manufacturing organization was that the implementation was deadline driven rather than quality driven. This is not a unique challenge to this organization. Many companies try to rush ERP implementations which often lead to failure. In addition, the organization faced the challenge of the project plans and schedules not being developed using actual work time requirements or considering the workload and available resources. The first two phases of the implementation used significantly more time from available resources than was originally planned. In order to prevent this in future phases of the implementation, the organization has decided to develop a capacity model that more closely aligns with the resources that will actually be needed during implementation. This will eliminate some of the strain on the employees and ensure the go-live process goes more smoothly in the future.

Lessons Learned Improvements

Figure 1 below represents the lessons learned improvements that the manufacturing organization has come up with to enhance the remaining phases of their ERP implementation. The items highlighted in red are the improvements the organization is making for future phases of implementation. Each of

these items relate to the core problem areas the organization faced during the first two phases of the ERP implementation.

Figure 1



The VSA process is tied to the business readiness of the organization. End-to-end value stream assessments offer organizations a structured approach to identifying opportunities and selecting the ones that align with their company's overall improvement objectives. This process is one that allows organizations to understand and analyze process improvement opportunities. It needs to be fully understood in order for an implementation to be successful. The improvement of data conversion processes and tools as well as job based training are also tied to business readiness. Ensuring an organization is ready for an implementation is just as vital as the implementation process itself. The improvement of volume and stress testing is an area of system readiness that the organization found to be lacking. Testing had been performed but not at the levels necessary to ensure implementation success. Improved volume and stress testing has now been added as a vital key to future phases of the implementation. The organization has decided that business process flow should be an area that is

measured for each stage of the implementation. A set of key performance indicators (KPIs) such as sales orders booked, shipments confirmed, and AR invoices paid, will be defined for each future deployment. The establishment of these KPIs shows the importance of the ERP implementation to the culture of the organization while also linking program governance. Performing reviews after each phase of implementation helps the organization to correct any short-comings before the next phase begins. This has been a crucial step in ensuring the success of the full implementation. It is also vital to not only look at the implementation phase of the project but all five phases of implementation to ensure success.

Conclusion

The purpose of this research was to identify challenges companies face when implementing an ERP system and how these challenges can be minimized. This study provides organizations with factors that are critical to the success of an ERP implementation. Employees are one of the largest factors affecting both successful and non-successful ERP implementations. There is a definite correlation between communication and training of employees to the success rate of an ERP implementation. Employees must understand why the change is necessary and how the new system will benefit them. During ERP implementation, it is vital to not only focus on ERP training but job training as well. Employees need to be taught to effectively use the updated systems their companies will be relying on. Organizations need to view ERP implementations as a business process implementation first and a system implementation second. It is also critical to establish intellectual honesty. You have to create an environment where people are not afraid to come forward with risks. Identifying risks as early as possible allows the organization the chance to overcome these obstacles. It is necessary for an organization to realize that it is not always possible to implement all features of an ERP system in the beginning. There will be plenty of time to later implement features that are not key to the initial upgrade. ERP implementations are journeys that should never be rushed. Finally, organizations must also realize that even successful

implementations have their challenges as is evident in the case study. Challenges do not have to translate to failure if an organization is willing to learn from them.

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A COMPARATIVE ANALYSIS OF CLOUD COMPUTING PROVIDERS: REVENUE, SERVICE MODELS, PRICING MODELS, AND OWNERSHIP STRUCTURE

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Introduction

Since the launch of public cloud computing technologies by top-tier providers such as Microsoft, Amazon, Google, and Salesforce in the early 2000s [9] [10], a variety of mid- and low-tier providers have entered the market [17]. These mid- and low-tier providers may leverage public IaaS or PaaS technologies offered by the top-tier providers, or may offer services on top of private or hybrid cloud configurations. As the breadth and depth of available cloud computing services expand, IT managers must have the ability to make informed judgments about the relative capabilities, service models, and pricing models of top-, mid-, and low-tier providers in order to maximize their organizations' ROI objectives. In addition, providers must keep abreast of trends in the cloud computing landscape in order to remain competitive and take advantage of growth or acquisition opportunities.

This study will evaluate the adoption of IaaS service models by top-, mid-, and low-tier cloud computing providers, as classified by annual revenue. Where prior studies have focused on top-tier cloud computing providers [9] [10] or performed limited analysis of "niche" providers [17], we will identify data from a broad variety of publicly-traded and privately-held providers with annual revenues ranging from less than \$1 million to \$100 billion.

Statement of the Problem

This study will develop understanding of the service models offered by IaaS cloud computing providers of various sizes, funding models, and public/private ownership. PaaS providers will be included in our data collection but excluded from our analysis, as we will conduct further investigation of PaaS providers in a separate study. In addition, SaaS providers will be excluded from this study, as we will focus on provider services that facilitate the provisioning, hosting, deployment, and management of applications rather than providers of end-user applications.

Purpose of the Study

The purpose of this study is to investigate service models of IaaS cloud computing providers. This study will perform a comparative analysis based on indicators of organization size, including annual revenue and ownership status (publicly-traded or privately-held). In addition, this study will investigate whether or not certain service models are more frequently associated with a cloud provider's acquisition by another cloud provider.

Research Questions

In this study, we will seek to address the following questions related to the adoption of cloud computing technologies and their impact on software application providers:

- Q1.** Is there a broad distribution of revenues of cloud computing providers? If so, what are the appropriate tiers for classifying the revenues?
- Q2.** Are IaaS service models more commonly offered by certain tiers of cloud computing providers than other tiers of providers?

Hypotheses

This study will seek to test the following hypotheses:

- H1₀:** Cloud computing providers' revenues are centrally consolidated around a particular range; all providers' revenues are comparable to one another.
- H1_a:** Cloud computing providers' revenues form a broad range with a weighted curve and distinct gaps or tiers.
- H2₀:** IaaS service models are not more commonly offered by certain tiers of cloud computing providers than other tiers of providers.
- H2_a:** IaaS service models are more commonly offered by certain tiers of cloud computing providers than other tiers of providers.

Brief Review of the Literature

Cloud Computing Defined

The National Institute of Standards and Technology (NIST) defines cloud computing as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” [13]. In addition, NIST identifies five characteristics of cloud models, including on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service.

Cloud computing studies discuss cloud computing three distinct service models [10] [11]. Infrastructure as a Service (IaaS) providers enable technology organizations to scale computing and storage capacity in virtualized environments. SaaS providers, which may themselves leverage public, private, or hybrid cloud capabilities, allow enterprises to adopt business applications. PaaS represents a model for software application developers (who may themselves be an “end-user” organization or a SaaS provider) to leverage common application modules, such as security frameworks, queuing services, and database services, in order to focus development efforts on domain-specific capabilities. These three service models are tightly linked, with SaaS leveraging elements of PaaS, which subsequently leverages elements of IaaS [8].

In addition to the distinct service models, cloud computing may be deployed in private, public, or hybrid clouds [6] [15]. Private clouds are established for the use of a single organization or for a single application provider and its customers. Public clouds typically include those offered by

Google, Microsoft, Amazon [9], and Salesforce [10] with services offered in a multi-tenant context (services run on top of shared resources or hardware, though that sharing is often abstracted so that end-users are unaware of other users' services). Notably, research addressing the stratification of the cloud computing market into top-, mid-, and low-tier providers is lacking, as much of the research identified in the literature review focuses on these top-tier providers and fails to address smaller providers, such as Parse or other mobile application PaaS providers.

Research Gaps

Studies of the characteristics of cloud computing providers have been limited in scope. As prior studies have focused on the dominant cloud computing providers including Microsoft Windows Azure, Amazon Web Services, Google App Engine [9] and Salesforce Force.com [10], analyses of mid-tier cloud-computing providers (such as Heroku and Parse) and low-tier cloud-computing providers (such as Appery.io and Mobile Roadie) have been limited to small samples [17] or have emphasized limited niche providers, such as open-source solutions [5], or providers serving specific market segments, such as scientific computing [19], education [12], and have not encompassed the broad spectrum of providers. In addition, these studies have emphasized either performance characteristics [7], or pricing, but have not simultaneously encompassed pricing and service models.

Research Design & Methodology

Cloud Computing Providers and Characteristics

We will conduct a content analysis of websites, journal articles, news sources, Internet blogs, investor reports, publicly-available shareholder information, and venture capital analyses to identify notable cloud computing providers. The content analysis will seek to identify the annual revenue, type of cloud computing services offered, and ownership type.

After gathering data, we will seek to identify patterns or common traits across the various cloud computing providers. We will then stratify the cloud computing providers into tiers according to revenue, based on whether or not clear stratifications exist across providers' revenues. We will also create a second classification based on ownership type (publicly-traded, privately-held). We will then seek patterns in the service models and pricing drivers across the segments identified by the revenue and ownership type classifications. We may also seek other patterns as may be determined through the course of the content analysis.

Service Models

Our research questions are specifically concerned with the types of service models, particularly Infrastructure-as-a-Service (IaaS) - in contrast to Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS) - offered by each cloud computing provider. Preliminary investigations of various providers found that IaaS and PaaS labels were used interchangeably and with significant variance in meaning from provider to provider. As a result, for purposes of our data collection, we define these service models as follows:

- *Infrastructure as a Service (IaaS)*
 - Inclusive of core hardware and system technologies, such as virtual machine instances, compute processing, and database hosting
- *Platform as a Service (PaaS)*
 - Inclusive of services that facilitate developer integration, testing, provisioning, or management of applications
 - May provide developer APIs or capabilities that abstract elements of software development or application management.

A cloud computing provider may provide both IaaS and PaaS services. Notably, we exclude from our study providers of IaaS hardware and software technology that sell technology to other providers but do not directly provide IaaS and PaaS services. For example, Cloud Foundry is an open source initiative that develops cloud computing technology but does not sell services directly to end users [2]. Instead, the Cloud Foundry technology is used by other providers to offer IaaS and PaaS services to end users.

While our data collection includes PaaS providers, our analysis in this study is explicitly focus on IaaS providers; further analysis of PaaS providers will be provided in a future study.

Private, Public, and Hybrid Cloud Services

An additional component of our service model research relates to the type of cloud services offered, including public, hybrid, and private IaaS services. As is the case with the IaaS labels, providers use the “public” and “private” labels with varying meanings. For purpose of this study, we use these terms as follows:

- *Private cloud services* – IaaS capabilities implemented and configured solely for use by a single client / organization; cloud providers offering these services may establish distinctly separate IaaS implementations for each customer
- *Public cloud services* – IaaS capabilities offered in a multi-tenant environment, wherein multiple clients’ services are implemented using shared resources and/or hardware (though sharing is often abstracted so that clients are unaware of other clients’ services)
- *Hybrid cloud services* – IaaS capabilities (public or private) offered in a manner that support integration with other IaaS services (which may themselves be public or private)

Corporate Ownership Status

In order to classify cloud computing providers and determine whether or not there are notable differences between publicly-traded and privately-held providers, we identify each provider’s public / private ownership status. If a provider has been acquired by another provider, then the ownership status of the parent provider is identified. In addition, we identify whether or not a provider received venture capital funding to support its operations.

Implementation

This section describes the steps taken to identify cloud computing providers and subsequently research each of those providers' characteristics. In addition, this section discusses the steps taken following data collection to both prepare the data for analysis and perform the analysis.

Identification of Cloud Computing Providers

As stated in the "Purpose of This Study" section, our study is focused on the broad spectrum of cloud computing providers. To begin our data collection, we referenced market research articles by Gartner [14] [18], which identified several IaaS and PaaS providers.

Next, we performed Google searches of "cloud computing providers," "top cloud services," "platform as a service," "infrastructure as a service," and "comparison of cloud computing providers." Those searches identified several sites [16] [4] [3], [1] containing articles or lists referencing IaaS, PaaS, and SaaS cloud computing service providers; upon review of those lists, organizations that could be immediately identified as SaaS providers were removed. The Gartner sources and Google searches identified a combined total of 256 organizations for study.

Survey of Cloud Computing Provider Characteristics

Given the 256 organizations, we established a review process for each provider, which included the following steps:

1. Perform a Hoovers database search for each organization's annual revenue (if available) and ownership type (if available).
2. Perform a Crunchbase search for each organization's service description and venture capital history (if available)
3. Perform a Google search for each organization's corporate website and any relevant sources describing services and pricing.

In the course of data collection, 79 of the 256 organizations were subsequently removed from inclusion in the study.

The cloud computing characteristic data was initially collected in an Excel spreadsheet. After collecting data for 177 cloud computing providers, the Excel spreadsheet was imported into a Microsoft SQL database. The data was then standardized to aid in systematic analysis; for example, "Yes" / "No" values were converted to database-friendly true/false values, revenue data was formatted to store numeric decimal values where data was available (and null values where the data was not).

Data Analysis

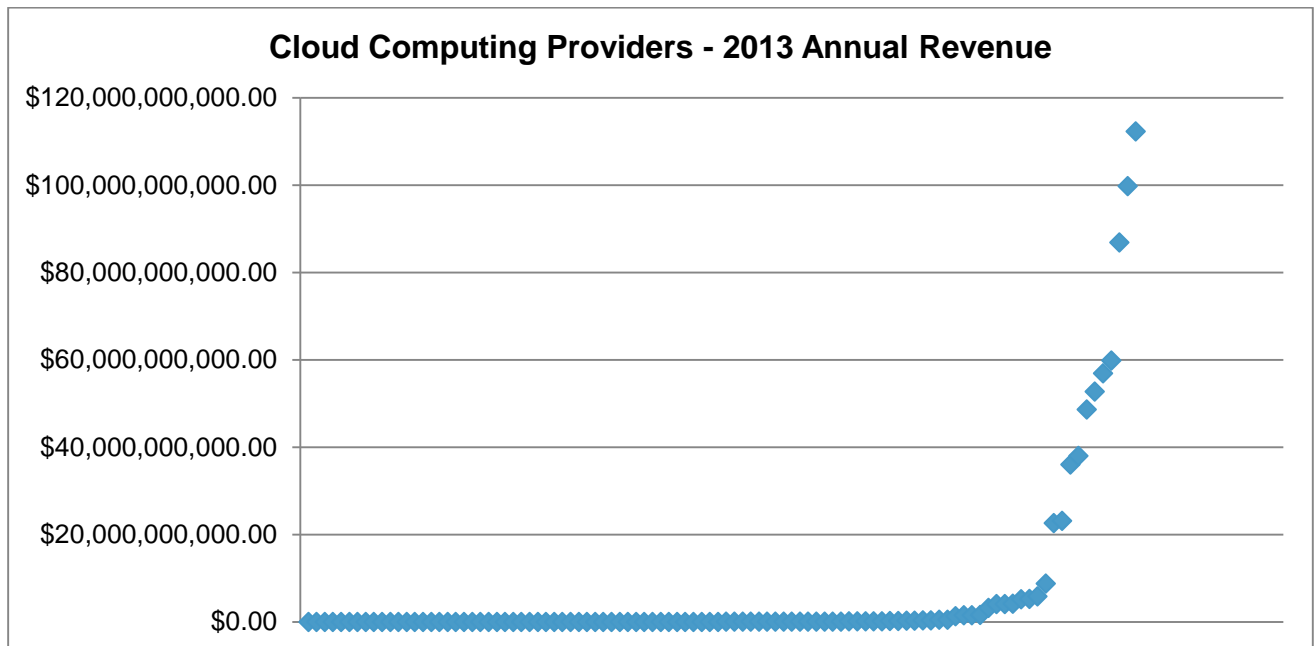
As anticipated by our research methodology, availability of annual revenue data is inconsistent for privately-held cloud computing providers. Our study was unable to identify annual revenue data for 75 providers; of these providers where revenue data is absent, 71 providers are privately-held and 4 were privately-held but have since been acquired by publicly-traded organizations.

Research Question 1 – Provider Revenue Tiers

Q1. Is there a broad distribution of revenues of cloud computing providers? If so, what are the appropriate tiers for classifying the revenues?

After collecting data for 177 cloud computing providers and standardizing it in a Microsoft SQL database, we began our analysis of the first research question. We retrieved the revenue data for 102 cloud computing providers and created a scatter chart to visualize the total distribution of revenues:

Figure 1 – Cloud Computing Providers – 2013 Annual Revenue



As visualized by Figure 1 above, cloud computing providers' revenues are distributed across a broad range and are not normally distributed. We therefore reject the null hypothesis and affirm the alternative hypothesis.

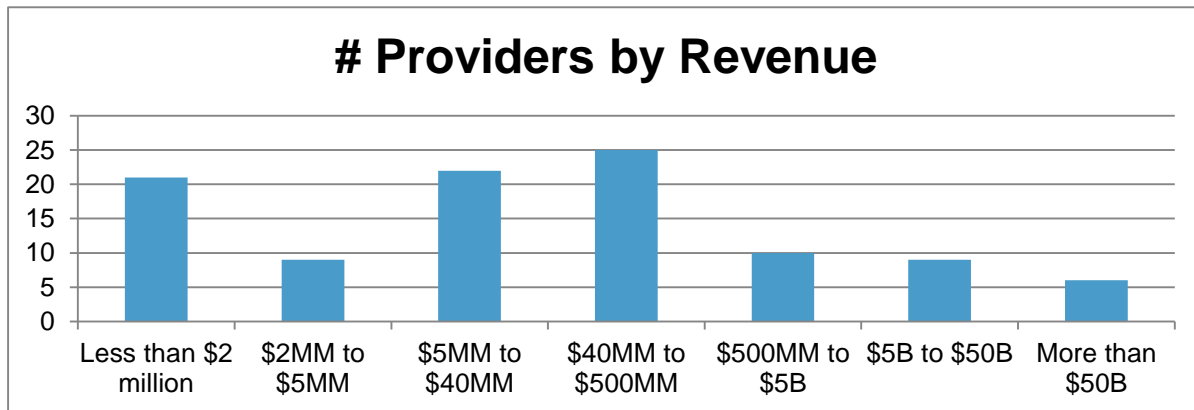
***Affirmed - H1a:** Cloud computing providers' revenues form a broad range with a weighted curve and distinct gaps or tiers.*

This finding is significant because it allows us to proceed with creating a classification of cloud computing providers by annual revenue. In order to do so, we created histogram charts in Microsoft Excel. The histogram charts identified bin intervals for grouping data points, which resulted in seven tiers:

| Revenue | Number of Providers in Tier |
|-----------------------|-----------------------------|
| Less than \$2 million | 21 |
| \$2MM to \$5MM | 9 |
| \$5MM to \$40MM | 22 |
| \$40MM to \$500MM | 25 |
| \$500MM to \$5B | 10 |
| \$5B to \$50B | 9 |
| More than \$50B | 6 |

Notably, the data do suggest that the “Less than \$2 million” tier could be further subdivided into “Less than \$1 million” and “\$1 million to \$2 million,” though our confidence in the accuracy of the revenue data for these providers is low. As a result, we have chosen to consolidate these ranges into the single “Less than \$2 million” tier shown above in Figure 2.

Figure 2 – Providers Classified by Revenue



Research Question 2 – IaaS Services by Tier

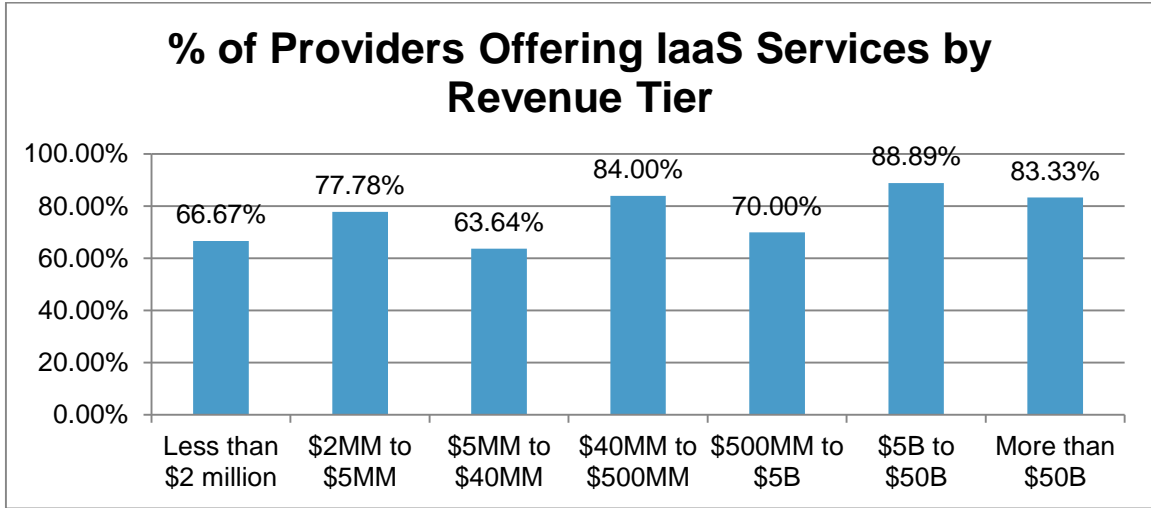
Q2. Are IaaS service models more commonly offered by certain tiers of cloud computing providers than other tiers of providers?

To fully explore this research question, we will evaluate the following dimensions:

- Providers Offering IaaS Services by *Revenue Tier*
- Providers Offering IaaS Services by *Ownership Type*
- Providers Offering IaaS Services by *Revenue Tier and Ownership Type*

Our analysis of the first dimension begins by confirming that are a sufficient number of cloud computing providers for which we have identified revenue data that offer IaaS services. Of 177 cloud computing providers included in this study, 124 offer IaaS services. Of those 124, revenue data is identified for 76, which we deem to be a sufficient sample upon which to perform our analysis.

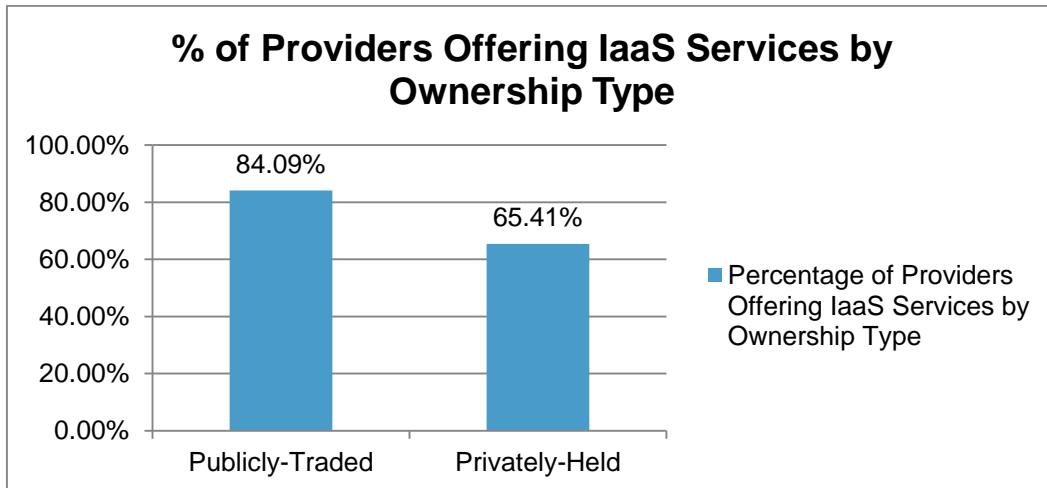
Figure 3 – Percentages of Providers Offering IaaS Services, by Revenue Tier



The data represented in Figure 3 suggest that cloud computing providers with a lower annual revenue are likely to offer IaaS services, though somewhat less likely than organizations with a higher annual revenue. In general, annual revenue alone is not a significant predictor of whether or not an organization offers IaaS services.

Our analysis of the second dimension quantified the numbers of privately-held and publicly-traded cloud computing providers. Of 177 total cloud computing providers included in the study, 133 are privately-held and 44 are publicly-traded. 87 privately-held organizations and 37 publicly-traded organizations offer IaaS services.

Figure 4 – Percentages of Providers Offering IaaS Services, by Ownership Type



From Figure 4 the data also suggest that privately-held providers are likely to offer IaaS services, though not as likely as publicly-traded providers. We find that ownership type is slightly more correlated with a provider’s offering of IaaS services.

For the third dimension, we identified the number of publicly-traded and privately-held providers by revenue tier (of a total of 102 providers for which revenue data is available).

Figure 5 – Providers per Ownership Type, by Revenue Tier

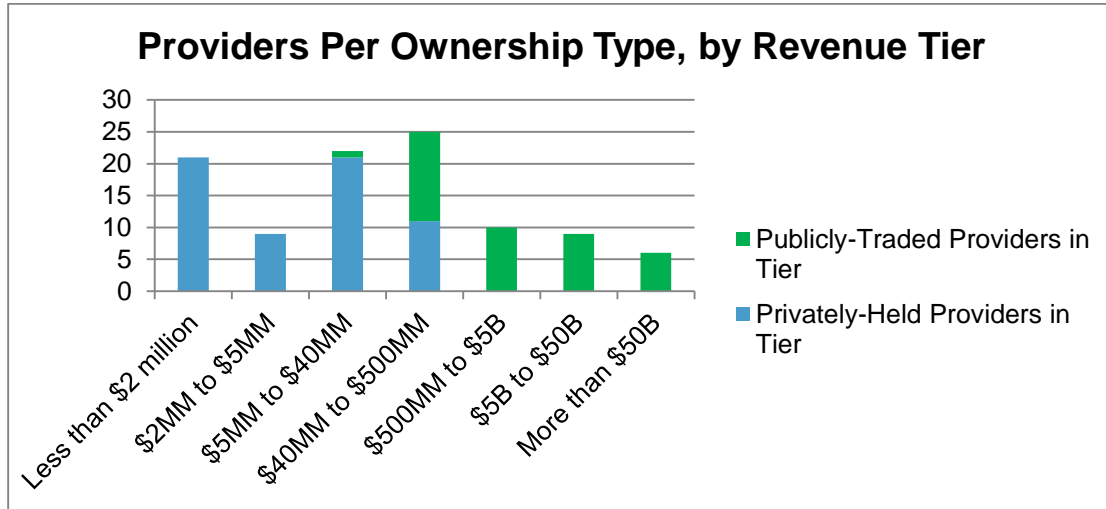
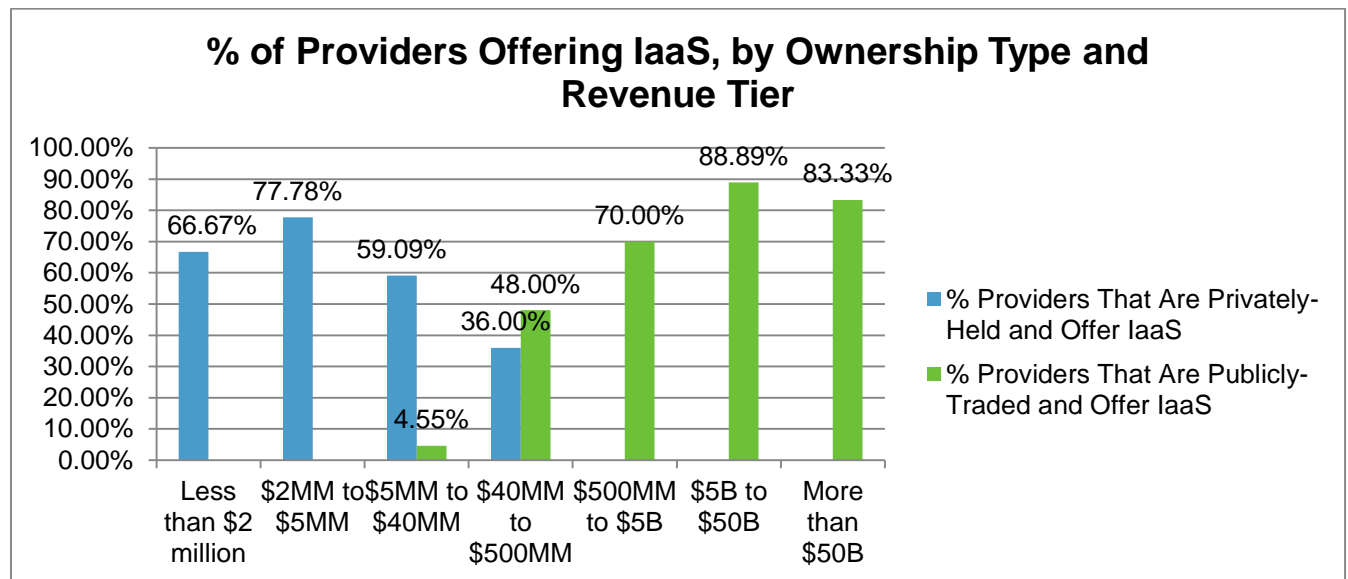


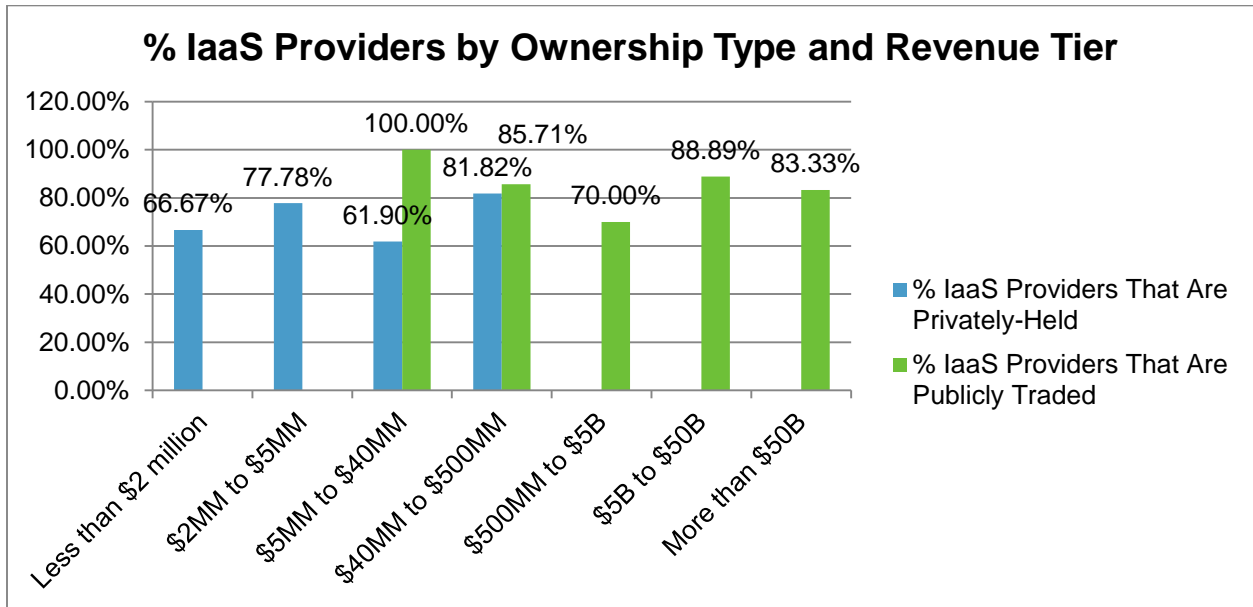
Figure 5 demonstrates that the top revenue tiers are directly associated with publicly-traded cloud computing providers. Next, Figure 6 identifies the percentages of the total cloud computing providers in each revenue tier that offer IaaS services, segmented by ownership type.

Figure 6 – Percentages of Providers Offering IaaS, by Ownership Type and Revenue Tier



Of the providers offering IaaS services in each tier, Figure 7 below, illustrates the proportions that are publicly-traded and privately-held in each tier.

Figure 7 – Percentages of IaaS Providers by Ownership Type, Per Revenue Tier



Given the consistency of the above data, we again find that privately-held providers, who generally have lower annual revenues than publicly-traded providers, are likely to provide IaaS services, but less likely than publicly-traded providers. We reject the null hypothesis and affirm the alternative hypothesis:

***Affirmed - H2_a:** IaaS service models are more commonly offered by certain tiers of cloud computing providers than other tiers of providers.*

CONCLUSIONS

The purposes of this study are to determine appropriate classifications for cloud computing providers based on revenue and determine if certain pricing models and service models are more commonly associated with certain classifications than others.

Our analysis identifies seven revenue tiers for classifying IaaS providers. In addition, we find that low- to low-middle revenue tiers are tightly aligned with privately-held cloud computing providers, while high-middle to high revenue tiers are tightly aligned with publicly-traded providers. The data suggest that IaaS service models are slightly more commonly associated with high-middle to high revenue tiers than lower revenue tiers.

These results may assist cloud computing providers in aligning their service models with those of similar providers in their tier. In addition, the results of our analysis may help providers determine possible ways to differentiate themselves from their competition, which will become increasingly important as new providers enter the cloud computing market and price competition reaches a floor.

Limitations & Concerns

Our research methods, data collection, and analysis relied heavily on qualitative analysis and subjective assessment of relationships between revenue tiers and service models. In addition, our data collection was limited to public sources and low-priced subscription sources (a Hoovers' database education license) and lacked direct hands-on access to more than a handful of cloud computing providers. As a result, we must note several limitations and concerns with respect to our findings:

- Revenue data for 75 of 177 cloud computing providers could not be identified, which could skew our results significantly
- The reliability of revenue data collected concerning lower-tier providers is more likely to be suspect than the reliability of revenue data collected concerning higher-tier providers; our results and conclusions are more likely to be accurate for publicly-traded cloud computing providers
- Given the qualitative nature of our methods, exact statistical measures were not used in our analysis
- Given the qualitative nature of our methods and research questions, we did not seek to suggest statistical correlation or causality in our statements of “common association”

Opportunities for Future Research

In the course of our study, we identified several opportunities for future research:

- Similar comparative analyses for PaaS service models across revenue tiers
- Comparative analyses of pricing models for IaaS and PaaS providers across revenue tiers
- Identification of additional revenue data (from reliably-updated sources) for privately-held providers
- Greater statistical analysis of revenue tiers, as well as their relationships with service models
- Identification of providers' founding dates and acquisition dates to determine market growth and/or consolidation trends
- Further segmentation of lower market tiers for niche cloud computing providers
- Study of cloud computing providers' use of specific cloud platform technologies

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A REVIEW OF THE LITERATURE ON SUPPLY CHAIN RESILIENCE: MAJOR FINDINGS AND DIRECTIONS FOR FUTURE RESEARCH

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ABSTRACT

The purpose of this paper is to investigate the research development in supply chain resilience. We undertake a literature survey to review the literature on supply chain resilience. This research answers two key questions: 1) What is the current state-of-the-work in supply chain resiliency? 2) What are the existing gaps and/or future research in supply chain resiliency? A sample of 84 papers collected, studied and analyzed. Several gaps are identified and valuable findings are obtained which direct future researches.

INTRODUCTION

The past few decades have been notable for major changes and trends in supply chains due to the increasing level of globalization, and higher rate of innovation (Kleindorfer and Saad, 2005; Tang, 2006a). From the financial perspective, throughout the 1990s, trends such as supply base reduction, just in time, lean supply chain networks and globalizations have inspired supply chain leaders to emphasize efficiency and cost reduction in the top priority for designing their supply chains by removing non-value added activities, wastes, and slacks resources in order to minimize their production costs (Tang and Tomlin, 2008; Manuj and Mentzer, 2008; Soni et al, 2014). Meanwhile, the growing role of global supply chains was associated with increased interconnectedness among suppliers and manufacturers which led to higher dependency among companies in the supply chains and higher level of supply chain complexity (Blackhurst et al. 2005, Wagner and Bode, 2006; Stecke and Kumar, 2009; Christopher et al., 2011).

While most of those supply chain leaders expected to see tremendous financial benefit in their companies after implementation of the efficiency-driven strategies, some of them were hit hard

by unexpected events that paralyzed their production systems. Fires in Toyota break supplier in 1997 and Philips Semiconductor plant in 2000, Hurricane Mitch in 1998, the earthquake in Taiwan in 1999, and New York terrorist attack in 2001 followed by East Coast blackout in 2003 and hurricanes in the Gulf Coast Region were just a few examples of events that demonstrated the inability of an efficiency-driven supply chain design. As the result of the negative consequences of these events, supply chain managers are considering the need to radical rethinking and changing attitudes toward the design of supply chains (Kleindorfer and Saad, 2005; Tomlin, 2006; Tang, 2006, Craighead et al, 2007; Knemeyer et al, 2009). Supply chains are also presently facing numerous changes such as high demand variability, short life of products and different expectations and requirements of customers which all are contributing to increasing their complexity and resulting in more instability and unpredictability (Stefanovic et al., 2009; Ghadge et al. 2012; Roberta et al, 2014).

We distinguish the year 2003, as the turning point on research in supply chain risk management. This contention is based on the result of literature review studies on SCRM by Tang and Musa (2011) and Ghadge et al. (2012). Their findings indicated a sudden jump in the number of articles published in SCRM in 2004. We assume that those articles published in 2004 had been started in 2002 and 2003 after the terrorist attack on September 11, which disrupted many supply chains around the globe.

SCRM is “the identification of potential sources of risk and implementation of appropriate strategies through a coordinated approach among supply chain risk members, to reduce supply chain vulnerability” (Juüttner et al., 2003, p. 201). Many researchers tried to investigate sources of risks and find solutions for dealing with them. While understanding sources of risks and disruption provided important insight to both researchers and practitioners, the notion of supply chain resiliency received more attention in the recent years. Melnyk et al. (2014) stated that resilience is the heart of current supply chain management thinking. Although the concept has been defined by many researchers, there is not a comprehensive definition that covers all aspects of previous proposed definitions together. For some, resilience is reactive capability that occurs after a disruption and others see resilience as more proactive efforts toward being prepared for disruptions. Melnyk et al. (2014) mentioned in the wake of these divergences, the confusion surrounding the concept is not surprising. For now, we rely on Ponomarov and Holcomb (2009) s’ definition. According to their study, supply chain resilience is “the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function” (Ponomarov and Holcomb, 2009, p. 131).

In this study we carry out a literature review on supply chain resilience. We aim to provide a platform for researchers and practitioners trying to identify the existing state of art and future directions on the topic. Thus, this research answers two key questions in supply chain resilience:

1. What is the current state-of-the work in supply chain resiliency?
2. What are the existing gaps and/or future research in supply chain resiliency?

The remainder of this paper is organized as follows. First, we review the existing studies in literature review of supply chain resiliency. Next, we present our research process and

methodology. Afterwards, we first present a statistics about the year and the location of each research study and next provide an overview of the research in terms of the definition of supply chain resilience and principles and drivers of supply chain resilience. In last section, we discuss major findings of this study and outline future directions.

LITERATURE REVIEW

There are three studies which have tried to conduct the literature review on supply chain resilience and therefore have some similarities with this study in some parts. In first study, Bharna et al. (2011) provided a review of resilience literature in its widest context and later its application within the organization. Using keywords such as “Resilience” and “Resilient SMEs” on databases and Google Scholar, they collected and analyzed 74 papers in which 21 papers were on organizational resilience and only 9 papers are on supply chain resilience. They focused on the perspectives, concepts and methodologies in the resilience literature. Their findings indicate that theory building has been the main focus of researchers within the area of resilience and the empirical studies are lacking. They suggested more focus on empirical methods such as case study and survey which can significantly add to and validate theoretical constructs.

Next, Ponis and Koronis (2012) reviewed 134 peer- reviewed journal articles. They investigated the concept of resilience in different area and came up with organizational and supply chain resilience. They identified the antecedents of SC resilience as agility, flexibility, velocity, visibility, availability, redundancy, mobilization of recourses, collaboration, and SC structure knowledge.

Finally, Roberta et al. (2014) employed systematic literature review approach to find the role of procurement in achieving supply chain resilience. Their research question is: “what are the intra and inter-organizational issues which must be addressed by procurement in order to create supply chain resilience?”. They studied 133 papers and limited their vision to 30 of those papers. They found enablers and barriers of supply chain resilience and interconnections between these factors and investigated their implications in procurement activities. Two frameworks of (1) intra- and inter-organizational issues from a procurement perspective to create supply chain resilience and (2) achieving supply chain resilience through intra and interorganisational issues were presented.

Our study differs from previous works in several ways: First, instead of conducting the review on the concept of resilience in other disciplines, we have only focused on organizational and supply chain resilience practices using a comprehensive and systematic literature review. Second, our review is comprehensive and covers practitioners and academic journal, book reviews, conference proceedings and other related reviews and reports. Using two methods for collecting different publications (Using databases and journals in the first phase, and track the references of the articles obtained in first phase in the second phase), our study covers all publications from 2000 to 2014. Finally, based on previous definitions and frameworks, we propose two definitions for enterprise resilience and supply chain resilience and provide a framework for supply chain resilience principles.

RESEARCH METHODOLOGY/PROCESS

In this study, we conduct a literature survey to review the existing body of literature on supply chain resilience. Literature survey aims at understanding important issues and challenges in supply chain resilience, including the current status and development tendency in the area (Tang and Musa, 2011). An approach comprised of two stages was used to collect the relevant publications in the topic: First, we searched databases and journals by using specific key works, and next, we track references of the publications obtained in first stage to determine the literature that we were not able to identify by using databases and journals. In preparing the sample for this study, we only considered the publications made after the year 2000. We further show that using year 2000 as the starting point is justified since the notion of resilience (especially supply chain resilience) was not discussed much before 2000.

1) Databases and Journals

We believe that the quality of a literature review study is driven by the data sources that are used. In order to identify high quality research papers, in line with Ghadge et al (2012), we decided to use quality rating of journals in three different domains of management: Operations Management (OM), Operation Research and Management Science (OR/MS), and General Management (GM) published by the Association of Businesses Schools (ABS), UK as it was vastly accepted in the academic world (Ghadge et al, 2012). For this purpose, a number of major databases such as Business Source Complete, Engineering Research Database, Taylor and Francis Online, Google Scholar, Emerald Insight, Science Direct along with top journals in OM, OR/MS, and GM were used to identify and collect the publications in supply chain resilience. A number of search keywords were used based on the terminologies used in supply chain risk management such as “supply chain resilience”, “resilient supply chain”, “enterprise resilience”, “organization resilience”, and “resiliency in supply chain”. Following the Databases and Journals approach, the target journals where the research papers obtained with their ABS ranking in scale of 4 are presented in Table 1.

2) Track References of Obtained Publications

The first approach was used to search for the articles within a limited number of journals with high score in the three areas of management mentioned based on ABS rankings (Table 1). In order to ensure all related articles are collected in this study, we conducted the second stage search to find relevant studies that have been published as conference proceeding, book chapters, or in journals out of OM, OR/MS, and GM scope. In each research paper we studied, we tracked the references of the paper as a mean of identifying relevant studies being cited by the authors. This helped to determine if there are any important studies that have not been identified in first phase of searching for publications.

The preliminary search using two search methods ended with almost 100 studies. We further refined this sample by setting exclusion criteria for the papers published in areas that were not related to organizational and supply chain resilience (e.g. material resilience). This procedure resulted in 84 quality research publications that are the basis of the literature review presented in this study.

Table 1

Identified data sources using Databases and Journals approach.

| Subject field/area | List of journals | ABS ranking ^a |
|--|---|--------------------------|
| Operation Management (OM) | Production and Operation Management | 3 |
| | International Journal of Production Economics | 3 |
| | Supply Chain Management: An International Journal | 3 |
| | International Journal of Production Research | 3 |
| | Computer and Industrial Engineering | 2 |
| | International Journal of Logistics: Research and Applications | 2 |
| | International Journal of Logistics Management | 2 |
| | International Journal of Physical Distribution and Logistics Management | 2 |
| | Journal of Business Logistics | 2 |
| | Journal of Supply Chain Management | 1 |
| Operation Research and Management Science (OR/MS) | Decision Science | 3 |
| | European Journal of Operation Research | 3 |
| | Omega: The International Journal of Management Science | 3 |
| General Management (GM) | Harvard Business Review | 4 |
| | MIT Sloan Management Review | 3 |
| | Supply Chain Management Review | 3 |

Note: ^aABS ranking as of 17 November 2010

RESULTS

1. Statistical Results:

In this section, we present an overview of the body of the literature on supply chain resilience.

1.1. Number of Publications per Year:

The number of publications each year during the year 2000 until 2014 (the time this study has been conducted) is shown in Fig. 1. The data shows that the concept of resilience emerged in supply chain literature around 2003. This finding is in line with findings of the literature review of SCRM by Tang and Musa (2011). They regarded challenges and opportunities of outsourcing to low cost counties as the most important research topic on that time period. Thus, it is reasonable that while discussion on outsourcing challenges has received more attention, the concept of SC resilience has received more attention in 2003.

The figure shows ups and downs in the number of publication until 2011, when a dramatic increase in the number of publications on supply chain resilience is noticed. This year (2011) is the turning point for the number of publications in SC Resilience, followed by 2014. Since this study has been conducted in middle of the year 2014, we expect that the number of publications in 2014 would surpass that of 2011. This increase in the number of publications indicates that the academic researchers and practitioners are becoming more aware of the importance of resiliency in supply chain.

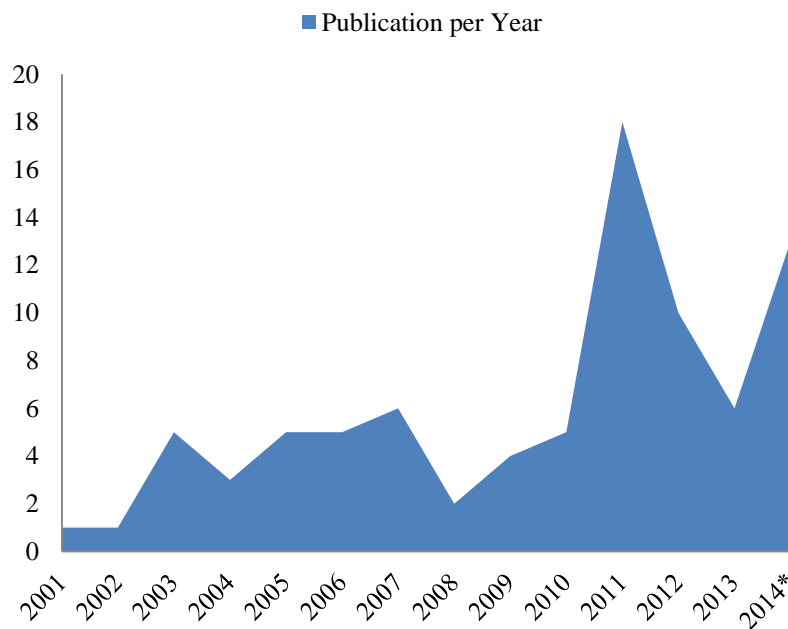


Fig. 1. Number of publications per year (* up to August 2014)

1.2. Number of Publications Based on Geographical Region:

The majority of publications have originated from US and Europe. We also identified a few publications by the Asian scholars. We considered the location of the first author as origin of the research. Figure 2 shows the share of each region in publications. The number of publications during this time period from each country is also presented in Fig. 3. The top three countries in the list are the US, UK, and Portugal.

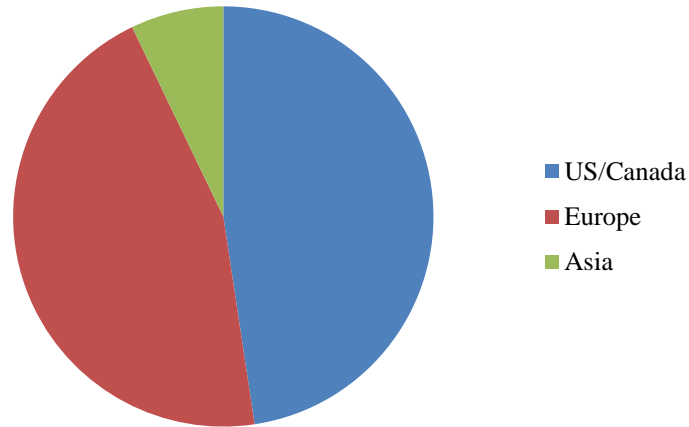


Fig. 2. Number of publications from each region.

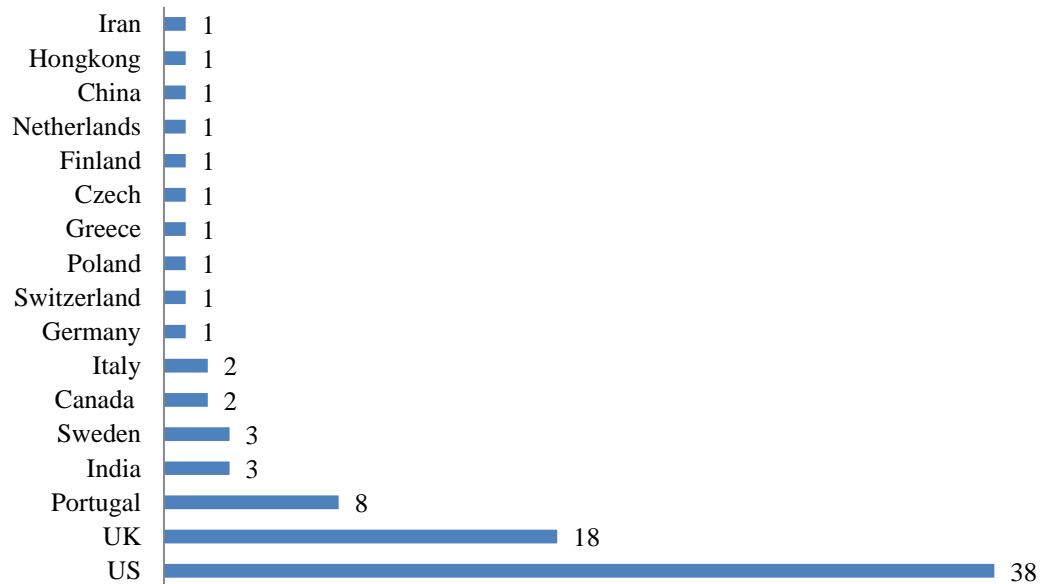


Fig. 3. Number of publications from each country.

1.3. Number of Publications Based on the Journal Classifications:

Figure 4 shows the number of publications in each classification: Operation Management (OM) journals, Operation Research and Management Science (OR/MS) journals, General Management (GM), reviews and book chapters, proceedings, or other journals outside the scope of OM, OR/MS, and GM (Others). The data shows that Operation Management literature has the greatest share of the publications with 45%. Interestingly, book chapters, conference proceedings and other are playing an important role in the literature of SC resilience by contributing to 38% of the

publications. General Management reviews and articles make 12% contribution in the literature. It is also interesting to see a limited contribution from OR/MS journals, which is only (5%). It indicates that the literature of SC resilience demands more contribution from OR/MS field.

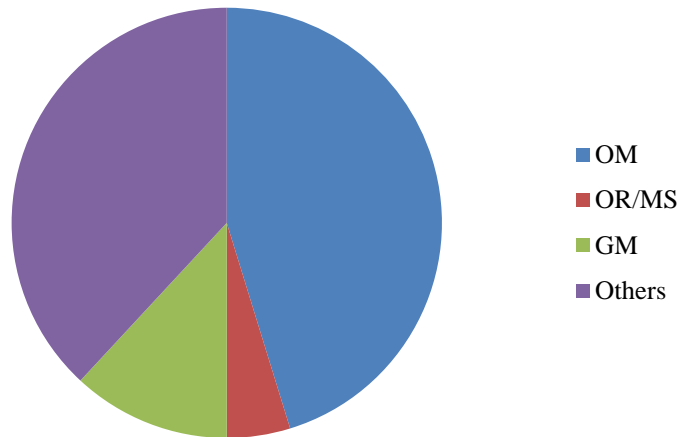


Fig. 4. Data sources of this study

2. Supply Chain Resilience:

The concept of resilience is multidimensional and multidisciplinary, which has its roots in psychology and ecosystems before being adapted in supply chain management field (Datta et al, 2007; Ponomarov and Holcomb, 2009; Burnard and Bharna, 2011; Bharna et al, 2011; Ponis and Koronis, 2012; Pettit et al, 2013). In order to define supply chain resilience, many researchers have investigated resilience definitions in other streams of literature based on the order that the resilience concept emerged on that field. Ponomarov and Holcomb (2011) studied the concept of resilience from ecological perspective, social, physiological and economic perspectives, emergency management and sustainable development perspective, organizational perspective, and SCRM perspective. Bharna et al (2011) presented different definitions of resilience in various fields of studies such as physical systems, ecological systems, socio ecological systems, psychology, disaster management, individual, engineering, organization, and supply chain. Ponis and Koronis (2012) scrutinized resilience in ecology, psychology, organization, and supply chain. Finally, Pettit et al (2013) referred to ecology, psychology, sociology, risk management and network theory to define resilience in supply chain. There are also some referrals to material science and engineering in some of previous studies (Sheffi, 2005; Pettit et al., 2010; Machado and durate, 2010; Soni and Jain, 2011; Murinho, 2011; Ponis and Koronis, 2012).

Since the purpose of this study is to carry out a literature review on supply chain resilience, through the process of studying the state of art on the topic, we tried to scrutinize all of the available definitions of supply chain resilience. Table 2 is a comprehensive and thorough source of supply chain resilience definitions proposed in the literature.

Table 2

Definitions of Supply Chain Resilience (SCRES) in the literature.

| Authors/year | Supply Chain Resilience definition |
|-------------------------------|--|
| Rice et al., 2003 | <i>“The ability to react to unexpected disruption and restore normal supply network operations”</i> |
| Christopher and Peck, 2004 | <i>“The ability of a system to return to its original state or move to a new, more desirable state after being disturbed”</i> |
| Sheffi and Rice, 2004 | <i>“It is firm’s ability to absorb disruptions or enables the supply chain network to return to state conditions faster and thus has a positive impact on firm performance”</i> |
| Gaonkar and Viswanadham, 2007 | <i>“The ability to maintain, resume, and restore operations after a disruption”</i> |
| Datta et al, 2007 | <i>“Not only the ability to maintain control over performance variability in the face of disturbance, but also a property of being adaptive and capable of sustained response to sudden and significant shifts in the environment in the form of uncertain demands”</i> |
| Falasca et al, 2008 | <i>“The ability of a supply chain system to reduce the probabilities of disruptions, to reduce the consequences of those disruptions, and to reduce the time to recover normal performance”</i> |
| Ponomarov and Holcomb, 2009 | <i>“The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function”</i> |
| Ates and Bititci, 2011 | <i>“The capacity of an organization to survive, adapt, and sustain the business in the face of turbulent change”</i> |
| Barroso et al, 2011 | <i>“The supply chain’s ability to react to the negative effects caused by disturbances that occur at a given moment in order to maintain the supply chain’s objectives”</i> |
| Juttner and Maklan, 2011 | <i>“The apparent ability of some supply chains to recover from inevitable risk events more effectively than others”</i> |
| Alberts, 2011 | <i>“Resilience provide an entity with the ability to repair, replace, patch, or otherwise reconstitute lost capability or performance (and hence effectiveness), at least in part and over time, from misfortune, damage or a destabilizing perturbation in the environment”</i> |

| | |
|-----------------------------|---|
| Ponis and Koronis, 2012 | <i>"The ability to proactively plan and design Supply Chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post event robust state of operations, if possible, more favorable than the one prior to the event, thus gaining competitive advantage"</i> |
| Carvalho et al., 2012b | <i>"Resilience is referred to as the ability of supply chains to cope with unexpected disturbances"</i> |
| Melnyk et al, 2014 | <i>"The ability of a supply chain to both resist disruptions and recover operational capability after disruptions occur"</i> |
| Brandon-Jones et al, 2014 | <i>"The ability of a supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed"</i> |
| Roberta Pereira et al, 2014 | <i>"The capability of supply chains to respond quickly to unexpected events so as to restore operations to the previous performance level or even to a new and better one"</i> |

A review of the definitions shows that they all consider resilience as the ability or capability of supply chains to respond to disturbances and disruptions. Disturbance is defined as “a foreseeable or unforeseeable event, which directly affects the usual operation and stability of an organization or an SC” (Barroso et al., 2008). The definitions proposed by Falasca (2008), Ponomarov and Holcomb (2009), and Ponis and Koronis (2012) are more comprehensive.

Based on the above discussion Supply Chain Resilience is defined as *“The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances by proactive thoughts and plans; resist them by maintaining control over the structures and functions; and recover and respond by immediate and effective reactive plans to transcend the supply chain to a desired and robust state of operations”*. Several terms such as “adaptability”, “flexibility”, and “agility” are implicit in this definition, which we will discuss them later. The above definition considers three phases for supply chain resilience, which are shown in Fig 5. These stages are described here:

- 1) Preparation (reduce the probability of disturbances): supply chains should be prepared for any expected and unexpected changes in the normal environment and functions. Managers must understand the disturbances they may face and their disastrous impacts, and try to minimize the probability of confronting these situations. Contingency plans should be planned and prepared for any emergencies.
- 2) Resistance to disturbances: As soon as a foreseen or unforeseen disturbance is detected in a supply chain, the ability of the chain to resist and deactivate the

perturbation before it expands would play a vital role in ensuring the continuity of the operations. A well prepared supply chain entraps interruptions in this phase.

- 3) Recovery and responses to disturbances: If the disturbances potentially have the ability to disrupt the supply chain, recovery, and immediate and effective responses based on the available resources are needed to minimize the negative impacts of disruptions on the chain. Well prepared responses should not only have the ability to reposition the firm to its pre-disruption status, but also transcends the firm's positions to a higher level, and can lead to competitive advantages. We need to mention that as we talk about the pace of the responses, we enter the realm of one of most important subsets of resiliency, namely agility. More information about agility can be found in next sections.

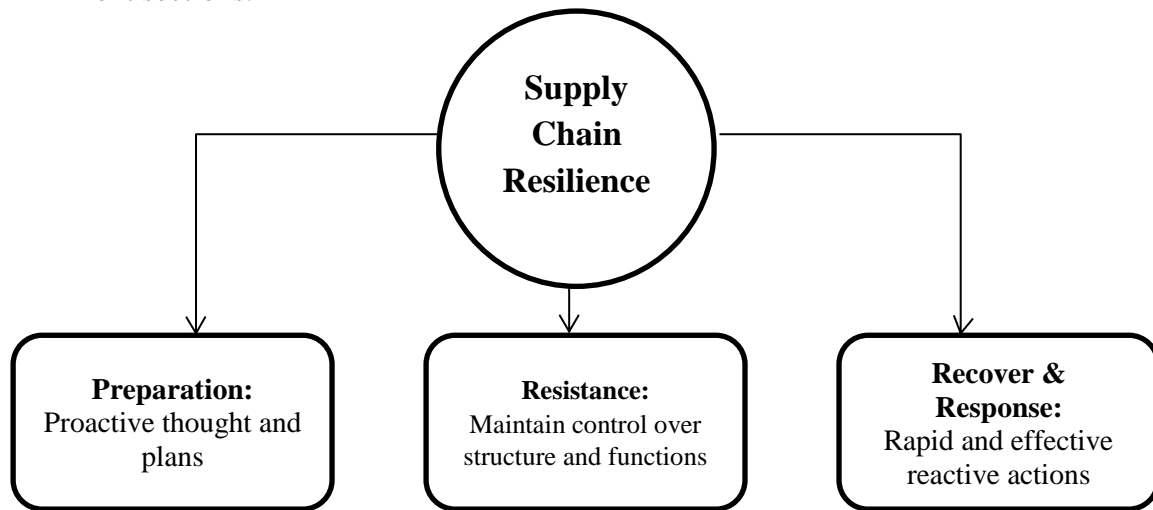


Fig. 5. Three Phases of Supply Chain Resilience.

3. Supply Chain Resilience Principles

Ever since the supply chain resilience topic has found its position in academia and practice, many researchers have tried to define its principles or the elements which make the supply chain more resilient. Although sometimes these elements have been used interchangeably by different authors, we try to distinguish them and identify supply chain resilience drivers. For this purpose, we review antecedents/enablers of supply chain resilience introduced by Christopher and Peck (2004) as one of the earliest studies, which has been cited many times later and seems to have made a basis for others (Briano et al., 2010; Christopher et al. 2011; Mandal, 2012).

Christopher and Peck (2004) defined four principles for supply chain resilience: 1) Supply chain reengineering, 2) Collaboration, 3) Agility, and 4) SCRM culture in the organization. Later, Christopher et al. (2011) adapted Christopher and Peck (2004) s' model for resilient supply chains to frame the strategies for mitigating global sourcing risks. Mandal (2012) conducted a survey on a sample of IT professionals in India to verify antecedents of supply chain resilience introduced by Christopher and Peck (2004). His findings indicate that supply chain managers must take Reengineering, Collaboration, Agility, and SCRM culture into account for the

designing future supply chains. Finally, Wilding (2013) introduced the four antecedents proposed by Christopher and Peck (2004) as four pillars for supply chain resilience.

The supply chain resilience principles discussed in this paper follow the framework represented in Fig. 6. This framework employs four principles of Christopher and Peck (2004) as the base. We then enhanced the framework through reviewing the literature, and exploring how researchers discussed and developed each principle. The arrows represent the relationships among the key variables in the model, which are mainly discussed in the literature. The dotted arrows represent relationships which are also suggested by some researchers. For example, while the effect of information sharing on resiliency is widely considered through enhancing collaboration, some researchers looked upon it as a direct supply chain resilience principle. Furthermore, there are also studies that considered information sharing as an enhancer of visibility. The interaction of flexibility and velocity is also discussed by some researchers. By showing some relationships with dotted line, we do not intend to imply they are not important. We would rather want to show these relationships are also suggested in the literature with less emphasis. In the following sections, we will review the literature to support the inclusion of the variables and their relationships, and how the model evolved over time.

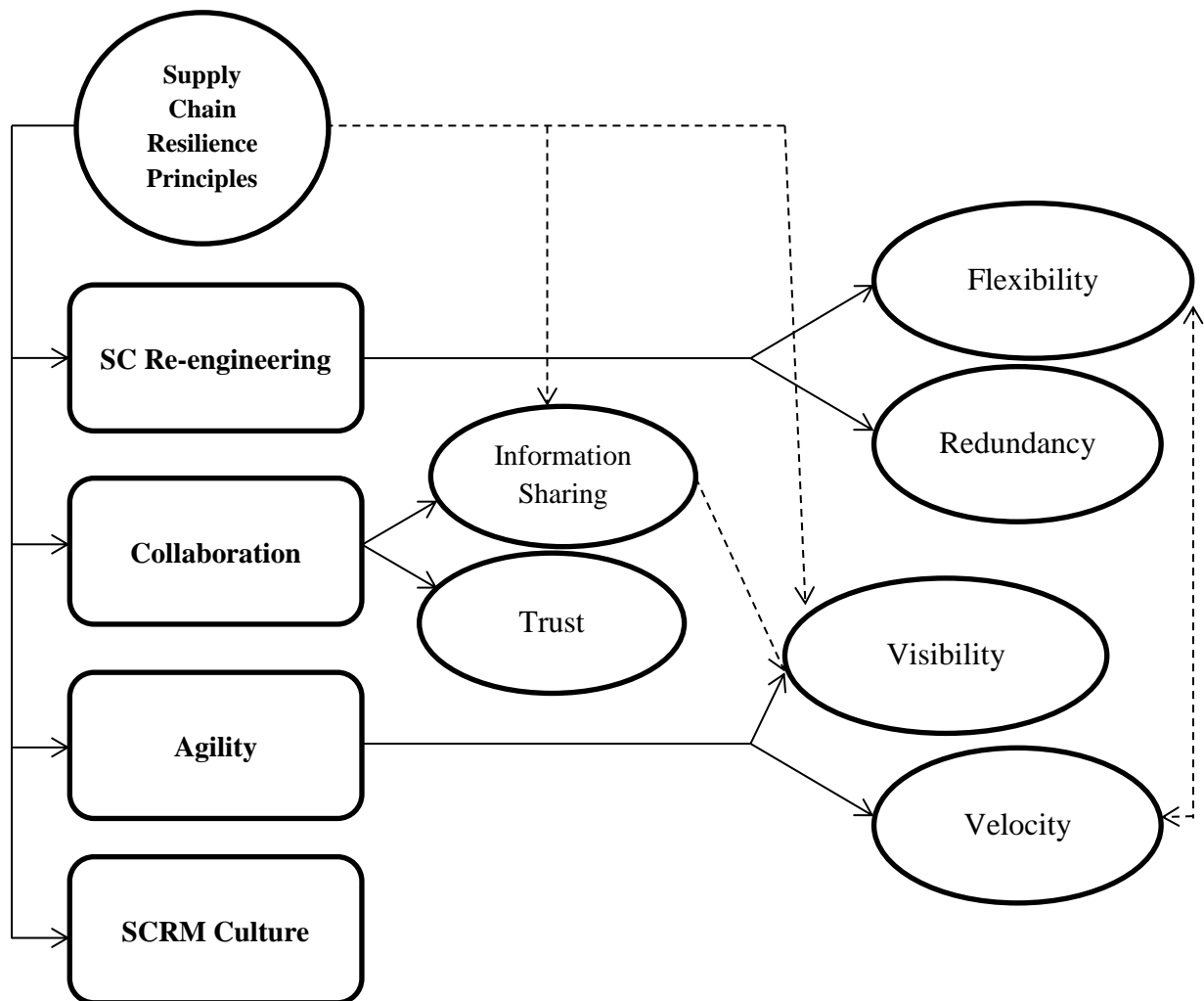


Fig. 6. Supply Chain Resilience

1. Supply Chain Reengineering

As we discussed earlier, supply chains are mainly designed to achieve two objectives of cost optimization and customer satisfactions. Given the risks and incidents inherent in supply chains, the need to incorporate SCRM into the design of supply chains has become more significant (Wilding, 2013). Therefore, supply chains that are designed based on traditional views need to be redesigned to integrate resiliency into their design. Ponomarov and Holcomb (2009) and Scholten et al. (2014) emphasized reengineering of supply chains and the need to build resilience into supply. Christopher and Peck (2004) underlined the importance of the following factors for reengineering of supply chains: 1) supply chain understanding, 2) supply base strategy (risk awareness of suppliers), and 3) design principles for supply chain resilience based on flexibility and redundancy.

2. Supply Chain Collaboration

Supply chains are extended across the globe, which are subject to risks and disruptions. This suggests that supply chain vulnerability is network wide phenomenon that needs to be addressed. Hence, the management of risk within the supply chain should be examined from a network perspective (Christopher and Peck, 2004). Risk management in a supply chain with high interconnectedness cannot be properly examined, unless a high level of collaboration, cooperation and partnership is current between the entities. Pettit et al (2010) define collaboration as “ability to work effectively with other entities for mutual benefits”. Faisal et al. (2006) construe collaboration as the “glue that holds supply chain organizations in a crisis together”. Collaboration and cooperation reduces uncertainty by distributing risk (Reinmoller and Van Baardwijk, 2005). According to Sheffi (2001) as lead times are becoming longer, emphasizing collaboration leads to better risk management in supply chains. An empirical study by Wieland and Wullenburg (2012) on the influences of relational competencies (communication, cooperation, integration) on supply chain resilience, reported that communicative and cooperative relationships have a positive effect on resilience, while integration does not have a significant effect. Bakhshi and Kleindorfer (2009) studied investments for supply chain resilience and found cooperative contract among partners in supply chain leads to efficient investment in supply chain security and consequently supply chain resiliency. Finally, result of a conducting a survey by Soni et al. (2014) showed that collaboration ranked 2nd among 14 enablers of supply chain resilience they proposed.

Despite all of the emphasize on collaboration and cooperation as one of the most important key factors of supply chain resilience, recent studies by Christopher et al. (2011) and Wilding (2013) both came up with the same finding that organizations tend to overlook the significance and importance on investment in developing collaborations.

Two elements which are mainly prerequisite for building cooperative relationships between parties are 1) Inter-firm trust, and 2) Information sharing.

2.1. Trust

According to Faisal et al. (2007), this dimension of the supply chain facilitates cooperation and collaboration both within the organization and across partners in the supply chain. Sinha et al. (2004) stated that lack of trust is one of the major factors that reduces supply chain risks. Ponomarov (2009) studied the mutual trusting behaviors of buyer supplier resilience and found that a greater degree of mutual trusting behaviors can cause greater relational resilience in buyer supplier relationship. His findings suggested that the longer the relationship orientation is, the stronger the relationship between mutual trusting behaviors becomes. Wicher and Lenort (2012) described a trusted network as a network where there is a certain degree of trust between the entities, where problems and challenges are openly discussed. In their study, trusted network is a requirement for design of the cooperative relationship and consequently it enhances resilience of supply chains. Finally, respondents of the survey conducted by Soni et al. (2014) ranked trust as the seventh important enabler of supply chain resilience out of 14 drivers.

2.2.1. Information Sharing as a Driver for Collaboration

Result of an empirical study on industry in India by Mandal (2012) indicated that collaboration can only happen when first and foremost each and every member observes the sharing of relevant information efficiently and effectively. His result also emphasizes the role of decision synchronization and incentive alignment in improving the collaboration among the parties. Wicher and Lenort (2012) stated that collaboration and relationships can be improved by data and information sharing, building trusted network and forecast and planning. Information sharing plays an important role in both before and after a disruption a supply chain. Investment in information sharing and monitoring the performance can help identify potential problems in supply chain (Melnyk et al., 2014). On the other hand, in accord with Soni and Jain (2011) such post disruption collaboration and information sharing is likely to have an effect on the system's ability to deal with future disruptions during all three phases: before, throughout and after the incident.

2.2.2. Information Sharing as a Driver for Resiliency

Some authors also argue considering information sharing a separate enabler of resilience from collaboration and visibility. Examples of these authors are Datta et al. (2007) and Soni et al. (2014). The former considered information sharing along with flexibility, regular monitoring and decentralized structure as four drivers of supply chain resilience. The later considered 10 enablers for supply chain resilience where information sharing, visibility and collaboration are considered three separate drivers. They also considered internal and external knowledge sharing as two antecedents of resilience in large enterprises. Finally, result of an empirical study by Blackhurst et al. (2011) indicated that six out of the seven firms in their study emphasized the need to have pre-defined communication protocols in order to mitigate disruptions through effective information sharing. All firms in their study stressed the need to develop supplier relationship management programs to mitigate supply risk.

3. Agility

Agility is defined as “the ability of a supply chain to rapidly respond to change by adapting its initial stable configuration” (Wieland and Wallenburg, 2012). Agility has been discussed in the literature from two different perspectives 1) as a driver of resiliency; and 2) as a separate element being examined as part of the agile supply chains (Carvalho and Cruz Machado, 2011; Carvalho et al., 2012). Since the focus of this study is resiliency in supply chain, we address the first view point and review the literature of agility in supply chain resilience.

Bakshi and Kleindorfer (2009) suggest that agility emphasizes “rapid system reconfiguration in the face of unforeseeable changes”. Wieland and Wallenburg (2012) stated that resilience has two dimensions. 1) The proactive dimension, which is concerned with “robustness”; and 2) reactive dimension, which deals with “agility”. Thus, agility is connected with responsiveness of supply chains in case of disruptions and emergencies (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009). Cabrel et al (2012) conducted a case study on Volkswagon and found agility as the most important component of their business. Among the 14 enablers of supply chain resilience proposed for the questionnaire survey conducted by Soni et al. (2014), agility received the highest rank, followed by collaboration, visibility, and risk management culture. Blackhurst et al. (2011) noted that four out of seven firms in their study discussed the need to be able to quickly redesign their supply chains to reduce the impact of disruptions. In a study by Taylor and Branicki (2011) on 11 SME decision makers, rapidity (i.e. agility) was perceived by the managers as an important capability to enhance resilience. However, the findings of a study by Christopher et al. (2013) indicated that a small number of leading companies are emphasizing “agility”.

Two components of agility which first were suggested by Christopher and Peck (2004) and later enhanced by other scholars are visibility and velocity (Faisal et al., 2006; Wieland and Wullenburg; 2012; Scholten et al, 2014; Azadeh et al., 2014). However, in some studies, flexibility is also assumed an element of agility (Chopra and Sodhi, 2004; Tang and Tomlin, 2008; Christopher et al., 2011; Ponis and Koronis, 2012; Scholten et al, 2014). Thus, further clarification is needed to properly address the relationship between agility and flexibility.

3.1. Visibility

Francis (2008) defined visibility as “the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times of these events” (Francis, 2008, p. 182). Visibility is simply defined as the ability to see one end of the pipeline, from the other end (Christopher and Peck, 2004). Pettit et al. (2013) defined visibility as the knowledge of the status of operating assets and the environment. The achievement of supply chain visibility is based upon close collaboration with customers and suppliers and it is an outcome of investment in information sharing (Christopher and Peck, 2004; Barratt and Oke, 2007; Soni et al., 2014; Brandon-Jones et al., 2014).

3.2. Velocity

Since the concept of speed is inherent to agility (Prater et al., 2001; Wieland and Walenburg; 2012) it is required to consider an ingredient for agility which carries the notion of speed and consequently notion of time. For this purpose, the concept of velocity has been evolved, which is one of the important building blocks of agility (Scholten et al., 2014). Christopher and Peck (2004) suggested that velocity means distance over time. Velocity in a risk event determines the loss that happens per unit of time (Jutner and Maklan, 2011). Barosso et al. (2011) emphasized the role of recovery speed in resilience by stating that supply chain resilience is achievable by redesigning the supply chain to mitigate adverse incidents and disruptions. Velocity is closely related with flexibility and adaptability; In fact, it focuses on the pace of flexible adaptations (Stevenson and Spring, 2007). Based on this relationship, some authors considered velocity in their flexibility definitions (Fiksel, 2006; Soni and Jain, 2011). The findings of multiple case studies by Jutner and Maklan (2011) revealed that velocity had a positive impact on the companies' revenue targets and supported flexibility by adding pace to the supply system's adaptability. However, when being compared to flexibility, velocity places a stronger emphasis on the efficiency rather than effectiveness of the supply chain's response and recovery (Smith, 2004).

4. SCRM Culture

According to Christopher and Peck (2004), organizations need to embrace a culture for SCRM in order to create a resilient organization. This emphasis on organizational culture has been previously observed as an important factor in success of other management practice, e.g. a culture for quality for Total Quality Management (TQM). Organizational behavior and characteristics are important drivers in the evolution toward resilient and sustainable enterprises (Moore and Manring, 2009). Sheffi (2005) stated that the key difference between successful and unsuccessful response to disruption is organizational culture. Companies such as Dell, Toyota, and Zara have been successful in creating the culture of flexibility. Waters (2007) also mentioned that risk management should be an essential element of every organization, which embedded into its corporate culture.

DISCUSSION: FINDINGS AND FUTURE DIRECTIONS

In this study, we examined two questions in the context of supply chain resilience:

1. What is the current state-of-the work in supply chain resiliency?
2. What are the existing gaps and/or future research in supply chain resiliency?

For this purpose, we employ a literature survey in this study to review the literature of supply chain resilience in SCRM, and investigate the research tendency of the field. It is the first literature review in SCRM area which particularly devoted to the study of enterprise and supply chain resilience. Several findings are extracted from this review and they can direct future researchers who would like to make new contribution in the area of SCRM.

We employed two methods to collect the related literature on supply chain resilience. In first method, we defined some keywords and used databases and journals to find the publications in high quality journals in three areas of management: Operation Management, Operation Research and Management Science, and General Management. We used the quality ranking published by Association of Business Schools (ABS) to distinguish between high and low quality journals. We further tracked the references of articles obtained by using the first method to cover other publications were made as conference proceedings, book chapters, or in journals out of three aforementioned area of management. By means of the two methods we used, 100 publications obtained which we then refined them to remove articles that does not have significant connection with respect to enterprise and supply chain resilience. After this process, 84 publications were selected and studied carefully. We then provided results in different sections. Below we summarize the findings and future directions of this study:

Statistical result: We presented some statistics about the time and location of the publications, and we found the year 2003 as the start point for emerging resilience concept in supply chain field. The data shows the majority of studies are conducted by researchers in US and Europe. We observed limited of publications in OR/MS field in supply chain resilience. Therefore, the first finding of this study indicates that the area of supply chain resilience requires more contributions from OR/MS field. Using the analytical tools and methods provided by operation research and management science helps to validate the proposed models in the literature but not tested yet. Since the stochastic models and simulations methods have the ability to model the dynamic nature of environment and incorporate risks, future researchers are encouraged to focus more on these tools to examine supply chain resilience quantitatively.

Supply chain resilience definition: We investigated the literature to find all of the definitions of enterprise and supply chain resilience. Through this process, we found that theory building is the main focus of the literature. This finding is in line with Bharma et al. (2011) who found same trend in the literature of resilience in various fields. We put all of the existent definitions of supply chain resilience next to each other in a table to provide the reader with the opportunity to compare and analyze them. We then found the important elements of previous definitions and proposed a new definition which covers all aspects of previous ones together.

Supply chain resilience principles: The literature on antecedents and principles of supply chain resilience is fairly rich. Nevertheless, lack of an overarching framework for supply chain resilience was evident in the literature. Based on the review of the literature, we developed a framework for supply chain resilience principles which we presented in Fig. 6. Our framework provides an appropriate conceptualization of supply chain resilience, and incorporates the major components of a resilient supply chain as discussed in the literature within a unified and cohesive framework. Thus, we believe the proposed supply chain resilience model (Figure 6) could be used by researchers in future studies to study supply chain resilience in a more systematic way.

Nevertheless, there are some key questions that remain unanswered and need further investigations. In the context of supply chain engineering, the relative importance of flexibility vs. redundancy is still unclear. While both flexibility and redundancy are being emphasized in the industry, there is little theoretical and anecdotal evidence to suggest which one should be emphasized first. Therefore, one of the key questions is to address the organizational and

contextual factors that could impact the selection of flexibility, redundancy, or both on supply chain resilience. In addition, the relationship between several key elements of supply chain resilience is not well understood and articulated in the literature. For example, the literature is not clear whether there is a relationship between flexibility and velocity. Finally, an important research question within the domain of supply chain resilience is the tradeoff between investment in capabilities to increase resilience (e.g. flexibility, redundancy, visibility) and their associated cost. Future studies should also address resilience through assessment of tradeoff among improvement in capabilities and their associated costs, and their impact of enhancing resiliency.

Our review of the literature also suggested that the trend has recently shifted from conceptual studies to empirical research. Those frameworks and principles were suggested by previous authors are being examined through empirical and analytical tools. Although the number of case studies and empirical studies are growing, there is limited use of analytical and quantitative approaches to examine enablers/antecedents of supply chain resilience.

CONCLUSION

We conducted a literature survey to review of enterprise resilience and supply chain resilience in SCRM area. Through this process we identified 84 publications including journal papers, conference proceeding, and book chapters. The target publications of this study covered a broad spectrum of areas such as global and regional supply chains. The concept of resilience from supply chain perspective was reviewed, and its antecedents were identified.

Through reviewing the literature a new definition for supply chain resilience based on the findings of the previous studies was proposed, and a framework for supply chain resilience principles was developed that incorporates major findings of previous studies into a cohesive and unified framework. We hope the findings of this study provide a comprehensive basis for future studies in the area of supply chain resilience.

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QUALITY FUNCTION DEPLOYMENT AND “SERVQUAL” APPLICATION IN A SERVICE INDUSTRY

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ABSTRACT

The purpose of this paper is to measure and analyze the level of customer satisfaction in a service industry using SERVQUAL instrument and the Quality Function Deployment (QFD) method. The SERVQUAL instrument is based on five service quality dimensions. The “gap” between each dimension’s expectation and perception was identified and labeled as “the voice of customers”. The SERVQUAL results were analyzed using QFD method. Recommendations were made to improve customers’ satisfaction.

INTRODUCTION

Ensuring the delivery of an excellent service and maintaining the highest level of customer satisfaction are two important aspects to maintain competitive advantage in a service industry. One of the ways to maintain and increase customer satisfaction is by offering customers unique and valuable experiences [3] and [6]. Experiences can be subjective as they derive from the inner feelings of a customer towards the service [5]. In some cases, a customer already had some expectations about the service quality before receiving the service. For example, customers expect “fast” and friendly service in a fast-food industry. Therefore, it is important for a service provider to ensure that the expectations match with the perceptions. If there is a positive difference (known as a gap) between perceptions and expectations, it indicates that the service provider has provided superior service than expected. However, a negative gap indicates that the service did not meet the customer’s expectations [7]. The quality of the service should be measured on a continuous basis as experience can change when there is a change in service environment. This paper measures the level of customers’ satisfaction in a service industry. The type of service industry is a yogurt shop.

Research Purpose and Methodology

The purpose of this paper is to measure and translate customers' experience using an instrument named SERVQUAL . [4] SERVQUAL instrument was adopted from [4].

There are two-phase of this research. Phase one of the research is the implementation of the SERVQUAL survey and phase two is the translation of the “voice of customers” using the house of quality method. The SERVQUAL instrument has two categories, the first category is to measure a customer's expectation and the second one is to measure a customer's perception. The five dimensions are tangible, reliability, responsiveness, assurance, and empathy. In addition, the house-of-quality/quality function deployment is used to analyze the result. Figure 1 shows the two-phase model of the research.

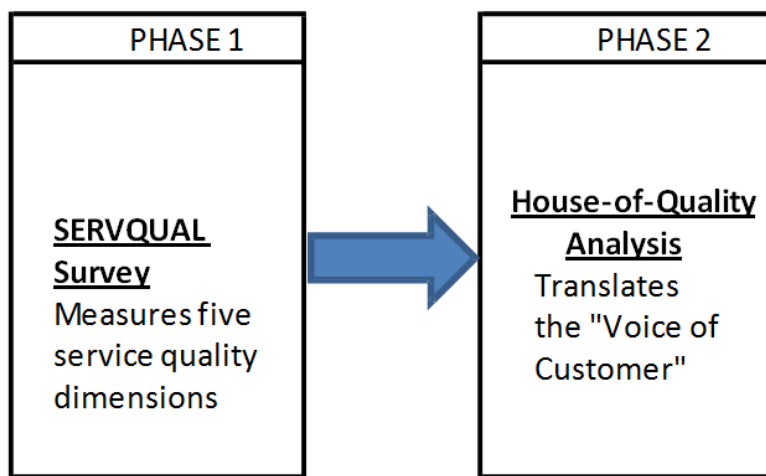


Figure 1: Two Phase Research Model

The respondents of the survey are customers of a yogurt shop located in Wilmington, North Carolina. Since this yogurt shop is located close to the University of North Carolina at Wilmington, the majority of the respondents are undergraduate students. For the purpose of confidentiality requested by the owner of the shop, the paper will not disclose the name of the yogurt shop. The goals of this yogurt shop are to provide the best product, achieve world-class customer service, and provide the most inviting atmosphere so that the customers can feel at home. This research is interested in measuring these goals using SERVQUAL instrument and translating the result using QFD method.

The first goal is related to the “tangible” dimension of the service. The “tangible” dimension measures a customer's experience and opinion related to the first goal of the shop. The second goal can be measured by reliability, assurance, and responsiveness dimensions. Tangible, empathy and assurance dimension will measure the third goal. The “SERVQUAL” instrument has the twenty-two questionnaires related to all five dimensions. There are two set of the “SERVQUAL” instrument, the first set is to measure expectation and the second is to measure the perception. It is like “before and after” concept. Before the delivery of the service,

the respondents were given 22 questions to measure the customers' expectation. After the service already delivered (a customer interacts with the staff, tastes the food, and explores the store surrounding) to the customer, the perception instrument with twenty two questionnaires was administered. The gaps are calculated based on the differences between the perceptions and expectations.

Analysis of the “SERVQUAL”: Phase1

The result of the study was analyzed using Excel. Each dimension's average and the gap between the perception and expectation for each dimension were calculated. Table 1 shows overall result of the “SERVQUAL” survey.

| Dimension | Expectation Score Mean | Perception Score Mean | Gap Score |
|----------------|---------------------------|--------------------------|-----------|
| Tangibles | 4.975 | 4.525 | -0.45 |
| Reliability | 5.38 | 5.58 | 0.2 |
| Responsiveness | 5.55 | 5.175 | -0.375 |
| Assurance | 4.7 | 4.9 | 0.2 |
| Empathy | 4.68 | 4.78 | 0.1 |

Table1: SERVQUAL result.

The result indicates that the tangible and responsiveness dimensions have negative gaps. A quality improvement is needed in these two dimensions. Empathy and assurance dimensions average score for both expectation and perception do not have negative gaps. However the average scores for both dimensions are lower than the responsiveness average. These dimensions deal with the personality of the staffs, the knowledge about the product, and the perceived willingness to help customers.

Quality Function Deployment Analysis: Phase 2:

The result of the SERVQUAL survey is the outcome of the “customers’ experiences”. These experiences are known as “the voice of customers”. In order to improve the quality of the service, the overall result of “the voice of customers” needs to be addressed in a systematic way. The phase 2 objective is to systematically translate and analyze the “voice of customers” using QFD method recommended by [1] and [2]. Figure 2 shows the overall steps of QFD method.

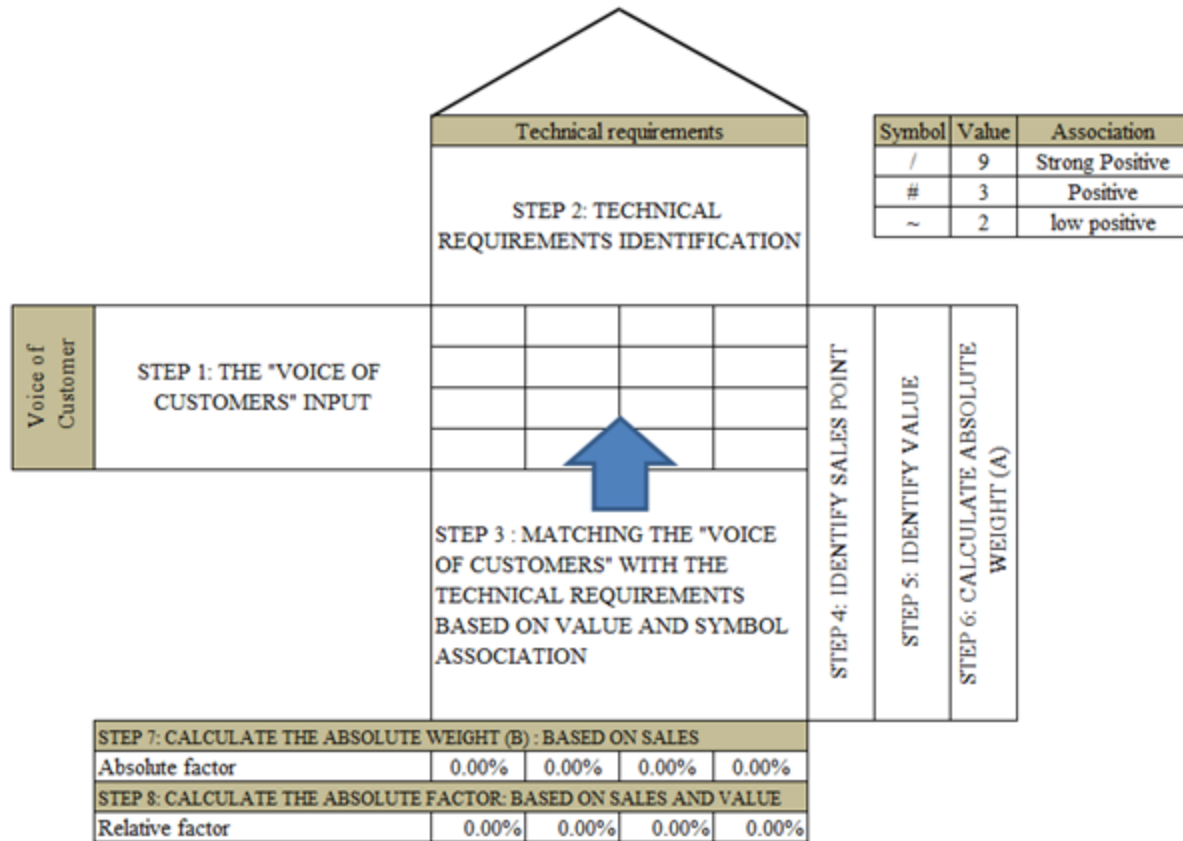


Figure 2: QFD overall steps.

The first step is to identify the “voice of customers”. In this study, the “voice of customers” has been identified based on the SERVQUAL survey result. The second step is to identify the technical capabilities of the yogurt shop. In order for the study (technical capability aspect) to be reliable, an input from a yogurt shop expert is needed to satisfy this step. An interview with the owner was conducted to verify the shop’s technical capabilities. The interview result indicates that there are four capabilities that can be implemented to satisfy the “voice of customers”. The next step (step 3) is to match the “voice of customers” with “technical capabilities. Matching process is based on how technical capabilities can be implemented to improve “the voice of customers”. Step 4 is to identify the “sales point”. In this study sales point input was identified during the interview process with owner. Identification of the “sales point”

is related to whether the steps (implementation of the technical capabilities) taken to improve the “voice of customers” will generate revenue to the business or not. For example, a clean floor may not generate higher revenue compared to adding a new yogurt machine. However, a clean floor may add “value” to the customers (step 5).

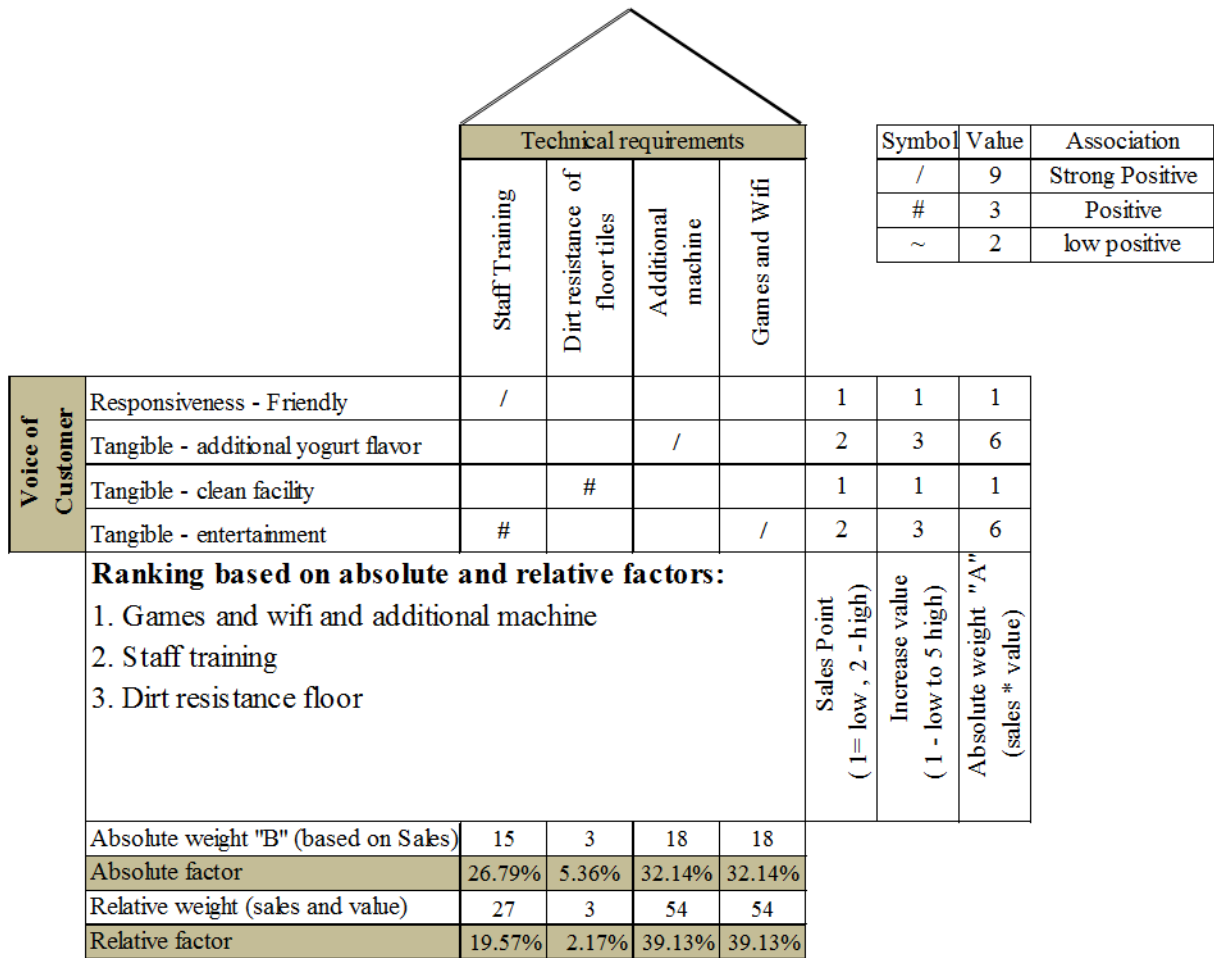


Figure 3: QFD result.

There are two levels in step 4 and 5, level 1 is the “low impact” level or when there is “no substantial impact on the sales/value” and level 2 is given when there is a high impact on the sales /value. Step 6, 7 and 8 calculate absolute weight and relative weight of the QFD. The result of the QFD analysis indicates that adding entertainment (games and Wi-Fi) and additional

machine have the highest score both results score are 39.13 percent. The relative percentage of staff training and floor cleanliness were 19.57 percent and 2.17 percent.

Conclusion

The result from QFD analysis suggests that the recommendation to add games and additional machine could improve the overall customers' satisfaction. Since the college group dominates the age demographic and background of the customers, the study indicates that this group seems to want "the experience" of having yogurt not limited only to the product itself but they also want the environment to be entertaining. The study suggests that the shop should add games and Wi-Fi to increase the level of "positive experience" of the customers.

Besides, the negative gap in the tangible dimension, the result of the responsive dimension also shows a negative gap. The data was collected during the end of fall season and in the beginning of winter season, which is considered the slow season for a yogurt shop. During this time there is only one worker per shift compared to two workers during the summer. Therefore could be a bias perspective in regard to the respondent input, for example, customers could perceive that one person is not adequate to provide good, quality and fast service especially when there is a rush.

The study has three limitations. First, the sample set is very small. Second, the demographics of the respondent are dominated by specific age group. Third, the survey was conducted during the Fall and Winter season.

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LEADER PERSONALITY AND THE SUCCESS OF IT INNOVATION ADOPTION IN A SMALL GROUP SETTING

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ABSTRACT

IT innovation adoption is a recurring and important topic in Information Systems (IS) research. Prior research posits a diverse array of tasks associated with each phase of the IT innovation adoption process. Alternately, literature in leadership demonstrates the galvanizing potential of leaders in achieving common goals. In this paper, we describe a proposed study that bridges two literature streams i.e., IS and leadership, to map and align the personality traits of leaders of small groups that are most beneficial during each phase of the IT innovation adoption process.

Keywords: Information systems, IT innovation adoption, leadership, personality traits

INTRODUCTION

Information technology (IT) innovation adoption is a salient research topic in information systems (IS) research. IS researchers have investigated various aspects of IT innovation adoption at the organizational, intra-organizational, inter-organizational, group and individual levels [30][9]. Much of this research has focused on investigating the determinants of IT innovation adoption at different levels of analysis [9]. Over the last three decades, the emergence of personal computers (PC's) and PC based applications has made computer technology exponentially pervasive in various aspects of an organization's functioning. Computer technology has migrated from the backrooms of information processing centers to the desktops of employees ranging from operational to top management of the organizational pyramid. Notably, use of computer technology has evolved from mundane number crunching operations, once the domain of insulated data processing centers, to routine information consumption, knowledge management and information generation activities. Connected by an intricate web of networks, constituents of modern organizations both create and consume information using PC's and PC enabled applications. The functioning of an organization is dependent on the simultaneous generation and consumption of this information by its various constituents using IT, many of whom operate within smaller sub units [17][12].

Unsurprisingly, an emergent area of IT innovation adoption research over the last couple of decades has been in the area of unearthing and investigating factors that motivate adoption and use of IT by individuals and groups of users within organizations [16]. Individual and group level adoption and use unlike that at other levels is concerned more with behavioral and perceived normative factors that motivate adoption and use of IT. A number of normative factors have been researched in prior research but leadership and the effect of 'championing' by leaders on employee 'buy-in' of IT innovations and practices is seen as a critical factor in successful IT

innovation adoption [33]. The influence of leaders in small work group environments may be particularly crucial due to the depth and frequency of interactions between a leader and other members of the team. Thus, leadership in small work groups presents a significant avenue for IT adoption related interventions and leader personality may have a non-inconsequential effect during the IT adoption process.

To test these assertions I describe a proposed study that draws from theory in both information systems and leadership literature to examine the relationship between the leader personality of a small to medium-sized team and the teams' success in IT innovation adoption.

THEORETICAL BACKGROUND & RESEARCH PROPOSITIONS

Big Five Personality Traits and Leadership

Leadership has been variously described in literature but it is generally agreed that leadership involves the process of influencing the behavior of a group of people to achieve a common goal. The leader may or may not have any formal authority. Theories in leadership have studied leadership based on leader traits, leadership behaviors and style such as charismatic leadership and narcissistic leadership, leadership as a function of the situation (situational and contingency theories of leadership), and using tangible outcomes such as performance measures and effectiveness (i.e. functional leadership theory).

Trait theory has been a major approach to the study of human personality in the field of psychology. Researchers in trait theory are primarily interested in the measurement of traits, defined as habitual patterns of behavior, thought, and emotion [15]. According to this perspective, traits are relatively stable over time, differ across individuals, and influence behavior. One of the most widely acclaimed trait models is the big five model.

The big five model is an empirical, data-driven research finding of personality traits. The five broad factors were discovered and defined by several independent sets of researchers[7] by studying known personality traits and then factor-analyzing hundreds of measures of these traits. In order to find underlying factors of personality, researchers analyzed self-reported and questionnaire data, peer ratings, and objective measures from experimental settings. One of the early models was that of [3] that involved 16 primary factors and 8 second order factors. Later models were advanced by Ernest Tupes and Raymond Christal in 1961 [7], but failed to reach an academic audience until the 1980s. In 1990, J.M. Digman advanced his five factor model of personality, which Goldberg extended to the highest level of organization [11]. The resulting five factor model has been found to explain most known personality traits and is assumed to represent the basic structure behind all personality traits providing a rich conceptual framework for integrating research findings in personality studies.

The big five traits of personality comprise of neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Neuroticism represents a lack of emotional stability and is characterized by the tendency to exhibit poor emotional adjustment and experience negative affects, such as anxiety, insecurity, and hostility. Extraversion is described as a positive affect displaying the tendency to be sociable, assertive, active, energetic and enthusiastic. Openness to experience is characterized by an individual's disposition to be imaginative, independent and

unconventional. Trust, gentleness and a caring nature is associated with agreeableness while conscientiousness is comprised of achievement and dependability.

Various studies have considered possible linkages between personality and leadership. Hill and Ritchie [13] suggested that self-esteem which is an indicator of low neuroticism is predictive of leadership effectiveness. There is also evidence indicating that neurotic individuals are less likely to be perceived as leaders [14]. Extraversion is strongly related to social leadership [5] and leader emergence in groups [32]. Creativity appears to be an important skill of effective leaders. Openness correlates with divergent thinking [23] and is strongly related to both personality-based and behavioral measures of creativity [8][24]. Correspondingly, research indicates that creativity is linked to effective leadership [27], suggesting that open individuals are more likely to emerge as leaders and be effective leaders. The link between agreeableness and leadership is somewhat ambiguous, however studies have suggested that specific aspect of agreeableness such as cooperativeness and interpersonal sensitivity tends to be related to leadership [2][34]. Conscientiousness is related to overall job performance and individuals' tenacity and persistence. Studies have found conscientious individuals to be more effective leaders [10].

Leadership can be conceptualized and measured in different ways but has typically been separated into two broad categories: leadership emergence and leadership effectiveness [20]. Leader emergence refers to whether an individual is viewed as a leader by others while leader effectiveness is described as the leader's performance and ability in influencing and guiding the activities of his or her unit toward achievement of its goals [28]. Of primary interest to the present study is measurement of leader effectiveness. Erstwhile literature suggests five categories of measuring leader effectiveness, one of which is evaluating leader effectiveness in terms of the actual performance of their team or organizational unit using objective measures of goal accomplishment or failure [26].

IT Innovation Adoption Literature

IT innovation adoption is a key research area in management information systems (MIS) research. Within MIS research an innovative technology may refer to any incremental, emergent, or radical and revolutionary change in IT products or related processes. Innovation adoption, as Damanpour [6] suggests, can also be the adoption of any idea or practice that preserves or improves organizational performance.

Erstwhile literature suggests that innovation adoption in firms and organizational sub units is accompanied by a need to change. In order to adopt a new process, a firm has to successfully utilize managerial capabilities [1] As noted by Sherif & Menon [25], accelerating and succeeding in innovation assimilation in firms, requires actors at different organizational levels to implement strategy, process and culture changes. Organization wide or group implementation of IT innovations has also been conceptualized to progress through a six stage model consisting of initiation, adoption, adaptation, acceptance, routinization, and infusion [4]. The six stage model proposed by Cooper and Zmud [4] is analogous to Lewin's [18] change model which describes change as a three-stage process. The first stage called "unfreezing" involves overcoming inertia and dismantling the existing "mind set". In the second stage the change occurs. The old ways are challenged but a clear picture regarding the replacement has yet to emerge. In the third and final

stage called "freezing" the new mindset crystallizes and one's comfort level starts returning to previous levels. As innovation moves through the various stages organizational actors such as senior managers, middle / project managers and operational staff are involved in the change process.

Extant research in information systems has examined the effect of various individual level factors on IT innovation implementation such as trust [19], emotion and affect [31], identity [21], self efficacy [22] and personality [29]. For instance, Zahra and George [35] analyzed IT innovation adoption through the cognitive absorption perspective and found that for decision makers, acquisition of facts and learning skills is important during the unfreezing stage while imbibing knowledge is important during the change phase. Similar research investigating the effect of decision maker personality traits on the implementation process is lacking where IS research on effects of personality on IT innovation implementation has primarily focused on the personality of the innovation user as a determinant of adoption.

| Table 1: Proposed Mapping of Personality Traits to Adoption Phase | | | |
|--|--|--|-------------------------------------|
| IS Adoption Factors and Tasks (from IS literature) | | Leadership and Personality Traits (from leadership literature) | |
| Adoption Phase | Related Leader Tasks | Desirable Leader Personality Trait for Accomplishing Adoption Phase | Personality Trait |
| Unfreezing | Active scanning of problem and possible IT solutions | Disposition to be imaginative, creative, independent and unconventional | Openness to experience |
| Change | Rational and political negotiations to gain organizational and intra group backing and commitment | Tendency to be sociable, assertive, active, energetic and enthusiastic | Extraversion |
| Freezing | Active encouragement of peers and subordinates to incorporate the innovation in day to day routine | Trust, gentleness , caring nature, and dependability | Agreeableness and Conscientiousness |

Thus, of particular interest (for this study) in the implementation process is the leadership intervention that is desired at each stage. During initiation (also known as the unfreezing stage), an active scanning of organizational problems and possible IT solutions is undertaken. The adoption, adaptation and acceptance stages (also known as the change stage) are dominated by rational and political negotiations to gain organizational and intra group backing and commitment. The final two stages (also known as the freezing stage) involve active encouragement of peers and subordinates to incorporate the innovation in day to day routine. In small IT development groups, this implementation process is driven by the team leader and its success may thus be more contingent upon the leader's personality [4].

Based on the characteristics of the task that a leader has to perform during each of the implementation stages the following propositions which align appropriate leader personality traits to the task characteristics for successfully completing the implementation stage are proposed.

Proposition 1: Leader openness to experience will be predictive of successfully completing the unfreezing stage.

Proposition 2: Leader extraversion will be predictive of successfully completing the change stage.

Proposition 3: Leader agreeableness and conscientiousness will be predictive of successfully completing the freezing stage.

PROPOSED METHODOLOGY

Experiment Procedure

This study will be conducted by involving students over the duration of one semester. It is not expected that the choice of student subjects as our sample will affect the generalizability of the findings as IT innovation implementation progresses through the same stages for students as it would for any other generalizable segment of the population. The students will participate in a study that involves IT innovation implementation of a web based document sharing program.

As a first step, information from students will be solicited to gauge their level of experience with IT and web technologies. This step will be carried out by administering a brief survey with questions pertaining to prior technology use, prior work experience in the IT field (such as software development experience), experience with document sharing programs and comfort in using web based software. This information will be used to organize the students into teams with approximately equivalent IT experience. The student with the most IT experience will be designated as the team leader. Following the completion of the first step and for an ensuing period of two to three weeks the students operating in teams will engage in various non-IT related tasks. This latent period will allow the teams to interact with each other and also form evaluations of the leaders' personality traits. At the start of the IT-related phase of the study, the teams will be administered a personality test to rate their perception of the team leader using the five factor assessment. The results will be stowed away for analysis.

After the latent period, students will be assigned case studies to be summarized on a weekly basis with one student designated per case study. The students will be asked to share their case study summaries with other students in their team using email. Every week a random member from each group will be asked to present a randomly selected case study in a short oral presentation. The objective of this assignment is to encourage the students to share the summaries of their assigned case study using the baseline technique (email). After one week, the leaders of each team will be asked to provide suggestions for alternative, cost-free ways to share documents among team members. The responses provided by the leaders will be used to indicate the presence or absence of the unfreezing stage. Following their responses, team leaders will be encouraged to implement the suggested technology in their team. This marks the beginning of

the change phase. After a few weeks, the team leaders will be polled again to track progress made in the change phase. Teams that have incorporated the document sharing program into their weekly assignment activity will be deemed to have successfully completed the change phase. To measure success of the freezing phase, team members will be surveyed towards the end of the semester to determine whether they would use the document sharing program implemented by their team in other contexts (other classes or personal use) thus marking successful routinization and infusion.

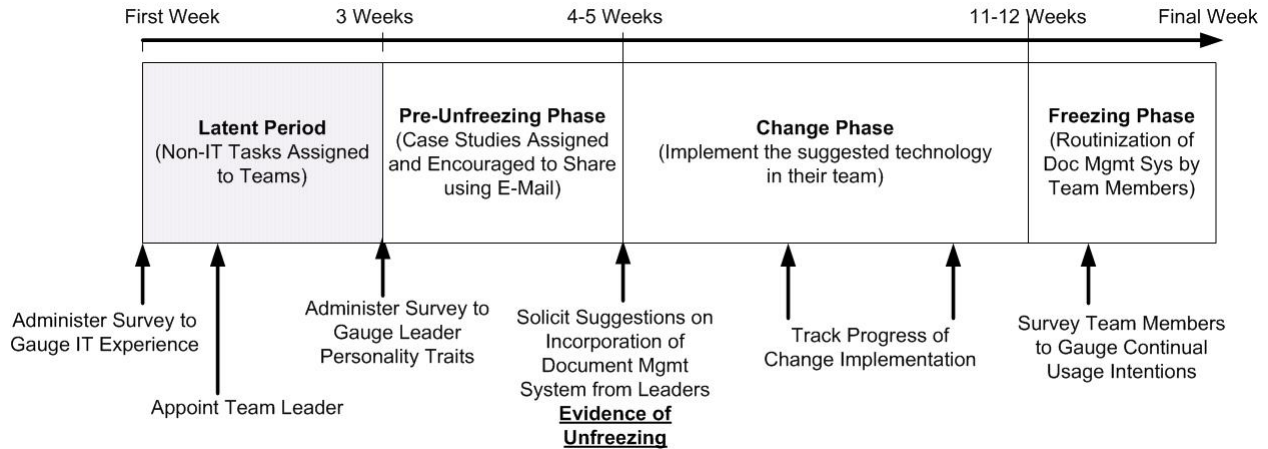


Figure 1 - Timeline of Proposed Study

Measures

The dependent variables for this study are completion of unfreezing, change and freezing stages. Completion will be coded as 1 while failure will be coded as zero. The independent variables used in this study are four of the big five traits of personality comprising of extraversion, openness to experience, agreeableness, and conscientiousness. Existing instruments will be utilized to measure the personality traits on a continuous scale. Prior experience with IT and computer self efficacy have been shown to affect user propensity to adopt an IT innovation [22]. These will be measured using existing instruments and controlled during the analysis.

Sample and Analysis

Using comparable studies as a benchmark [21] a 5% margin of error and 95% confidence interval level a sample size of 377 students will be required to complete this study. By involving two or more undergraduate classes with an average enrollment of 40 students, the data collection for this study can be completed in three to four semesters. Given that the dependent variables are dichotomous and the independent variables are continuous, logistic regression will be used to analyze the data.

CONCLUSION

Increasingly, the pervasiveness of IT in the modern competitive environment has forced firms to automate, informate, and even transform their business practices to align with and leverage the capabilities of information technology. In such an environment adoption inertia and resistance

towards adopting newer IT systems can lead to not only failures of capital intensive IT systems implementation initiatives, but also to an organizational failure to compete by utilizing newer IT capabilities and lag behind more IT savvy competitors. In light of this, a key imperative of organizational managers is to provide effective interventions that facilitate IT adoption. In this paper we investigate one avenue for an intervention which originates from vestiges of leadership capital held by many firms. By mapping leadership personality to the tasks at hand during the IT innovation adoption process, we provide clarity on how the personality traits of leaders may determine the success or failure of each adoption phase.

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ERP TRAINING IN CONSOLIDATION

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ABSTRACT

Effective training continues to be a necessity for any successful organization. Adequate time is of ultimate importance to develop appropriate training courses and ongoing support for employees. This paper explores training in an Enterprise where in addition to adult learning techniques, emotional intelligence should also be employed to mitigate the classic training resistance that is intensified by the consolidation of two institutions of higher education.

INTRODUCTION

Training continues to be a rite of passage to successful business operations including the use of Enterprise Resource Planning (ERP) Systems. This paper discusses the inadequate training provided at an institution of higher education for many reasons including lack of one particular resource: time. The significance of this discussion is the ERP system's effect on accurate financial reporting of the institution. The ERP system is also used to determine compliance of several areas within the institution. The institution recently underwent a significant change that required training on the use of an ERP system. The timeline for implementation was one year.

ERP HISTORY

ERP systems are highly complex and were created to increase the efficiency of business operations to yield a competitive advantage. They operate along defined business processes and have the capability to integrate not only departments within a company, but also vendors, customers, and other agencies [12]. Initially, ERP systems were only available for larger organizations that could afford the costly implementation. Over the years and with changes in technology, these systems have become more affordable and accessible to businesses of various sizes. There continues to be costly failures of ERP system implementations.

The pivotal component of ERP systems is access to real-time information for automatic process initiation and better decision-making proficiency. Enterprise systems are a multi-million dollar industry. The leaders in the industry are SAP, Oracle, and Microsoft [3]. Sixty-seven percent of enterprise initiatives are considered negative for achieving corporate goals. Over forty percent of large projects fail. Some of the identified causes of those failures include leadership (42%), organizational and cultural issues (27%), people issues (23%), and technology or other issues (8%) [12].

ERP systems are often associated with downsizing, increased management control, job deskilling, and work intensification. The integration of departmental tasks and processes along with increased access to data typically eliminates jobs and changes the nature of others. Robust reporting fuels faster, more accurate decision making and reveals problem areas, often including employees. Job deskilling refers to an employee's perspective of a job becoming a routine of meaningless tasks. It occurs as a result of loss of employee empowerment. Employees often have less decision making capability due to the uniform transactional nature of ERP systems. Work intensification refers to increased employee responsibility of routine tasks [7].

A different perspective says that ERP systems improve communication, integration of business processes, and working relationships as employees work to understand how to use the system to its fullest potential in performing their jobs. This perspective is based on the idea that employees are engaged and motivated and that training must continue post-implementation in order to meet company implementation objectives. The complexity of ERP systems require the understanding of the underlying business processes for the greatest opportunity for efficient and effective use [2].

MERGERS

Mergers and acquisitions are common in today's marketplace as a means of adding value to a particular company. The substantial changes, ambiguity, and uneasiness that results from mergers fuels employee distrust and turnover. The lack of organizational authenticity intensifies these results. Organizational authenticity is defined as the integrity of an organization. A study (identify study) shows that the lack of organizational authenticity results in lower employee productivity, negative relationships, and strained trust; all of which impact the success of the merger [4]. Merging companies that excel in the Big Six also outperform their competition in bottom line performance. The Big Six are:

1. Leading-inspiring confidence in the change,
2. Communicating-communicating the rationale for change,
3. Learning-identifying new accountabilities,
4. Measuring-clarifying metrics to define success,
5. Involving-creating and inclusive environment,
6. Sustaining-ensuring change remains [9].

TRAINING

Effective training is important in any organization to ensure work is performed correctly. Training, education, instruction, and learning are all part of a knowledgeable workforce. Stolovitch and Keeps [15] define them in this way:

1. Training-cause learners to consistently reproduce a task without variation,

2. Instruction-help learners to apply learning beyond specifics of teaching,
3. Education-derived from various life experiences and builds mental models and value systems,
4. Learning-the ability to adapt to new information.

Organizational training typically consists of Power Point presentations and lectures. Reference material is sometimes offered. Engaging instructors involve the audience to increase information retention and employee participation. Computer-based training offers the same information in a self-paced environment. When training accounts are provided, they are not fully functioning resulting in limited hands-on software training. Additionally, every possible scenario cannot be tested because they are unknown. Ability, prior knowledge, and motivation impact how well and how much people learn cognitively. Adult learners have specific needs regarding learning that should be addressed even in the workplace [15]. Malcolm Knowles' andragogy research is well documented and lends assistance to areas to be addressed in the instruction of adults [15]:

1. Readiness-How is this relevant?
2. Experience-Relate to employee's experiences,
3. Autonomy-Empower employees,
4. Action-How does this help me right now?

TRAINING RESISTANCE

Mandatory training often has a negative connotation. Employees wonder if it is worth their time and how will their workload be affected. While some welcome the training hoping that it will assist them in improving their job performance or efficiency, others go into training with the decision made to give minimal participation in an effort to finish training as soon as possible. According to Stear and Willis [14], there are four factors of employee reactions to training when computers are involved:

1. Perceived value of learning in relevance and validity,
2. Attitude towards the trainer in facilitating the learning process effectively,
3. Response to learning conditions in providing a suitable environment,
4. Desire to learn in the degree to which trainees really want to learn and do well.

In a study of user acceptance of ERP systems, it was found that perceived usefulness and perceived ease of use directly affects the attitude and behavioral intent of employees. The presence of the attributes of perceived usefulness and ease of use improves the opportunity of user acceptance [13]. Additionally, the following nine principles can be used to decrease employee resistance in the development of employee training [1]:

1. Identify trainees' strengths and challenges relating to motivation,
2. Align learning objectives to organizational goals and show how learning is important to trainee and company success,
3. Describe goals and objectives prior to the start of the training,
4. Engage the learners to maximize attention, expectations, and memory,

5. Use logical sequencing of learning activities according to Bloom's Taxonomy,
6. Use variety of training methods,
7. Use realistic job or life training materials,
8. Allow trainees to work together and share experiences,
9. Provide constant feedback and reinforcement while encouraging self-assessment.

Another important factor in decreasing employee resistance to training is the perceived support from the organization. Employees who feel appreciated tend to be more dedicated in training and the challenge to achieve prevents resistance [8]. Teaching only the portion of a process that an employee is responsible for is likely to demotivate them. Knowing the entire process and the effect and importance of one's individual role in a process serves as employee job enrichment [10]. Self-efficacy can be another hurdle to training. Self-efficacy is defined as one's perceived ability to perform a given task and to cope with challenging situations. It is one of the most critical factors influencing the activity of a person [2]. Social capital can greatly influence post training implementation. Social capital refers to the forming, transferring, and maintaining of knowledge among colleagues by usual daily interactions in the course of business [2].

TRAINING FRAMEWORK

After considering all of the learning styles, motivational challenges, and limitations of training, it would be beneficial to apply those attributes to a framework when developing employee training programs. One such structure is the five- step model for structuring training as shown below [15]:

1. Rationale-Why this should be learned and how it applies to your work,
2. Objectives-What you will be able to do after training,
3. Activities-Meaningful and engaging,
4. Evaluation-Assess what has been learned,
5. Feedback-What was learned and what needs to be improved.

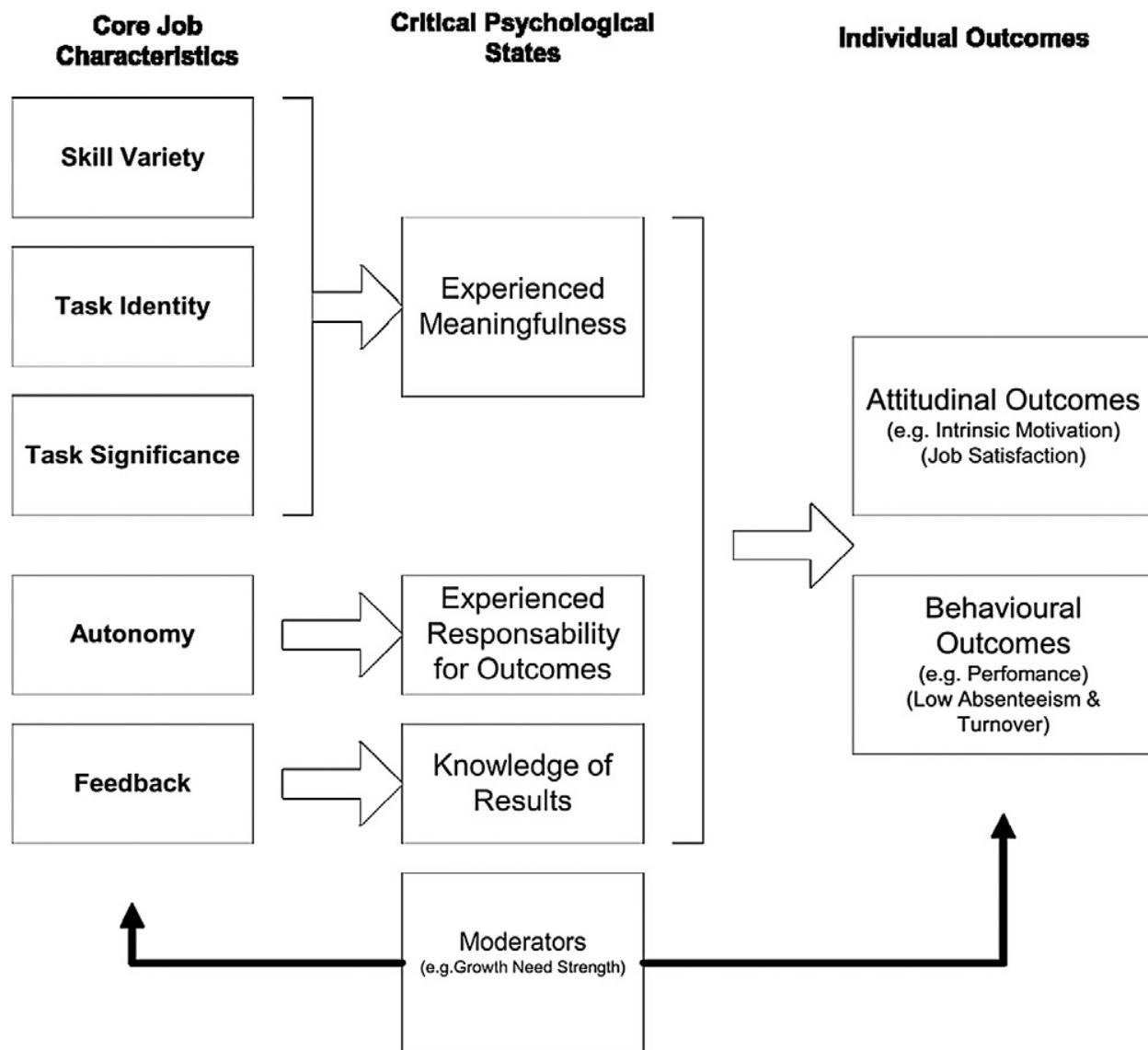


Figure 1: Job Characteristics model [6].

The Job Characteristics Model (JCM) supports the idea of employees being more engaged if their jobs are intrinsically rewarding. Jobs with characteristics that feed into the critical psychological states produce the greatest performance outcomes [10]. Experienced meaningfulness includes skill variety, task identity, and task significance. Skill variety is the range of skills required for job performance. Task identity refers to the opportunity to complete a job from start to finish as opposed to only a portion. Task significance relates to how an employee feels their job impacts others. Autonomy is linked to experienced responsibility for outcomes, specifically as employees perceive they have the freedom to assess and respond to situations in a way that reaches desired job objectives. Autonomy is often hindered in an ERP environment when used in a centralized nature. Feedback refers to direct communication regarding the quality of one's job performance. It is necessary for adequate improvement. In an ERP environment, feedback is usually prevalent in managerial roles and lacking in operational roles [10].

Trainers could consider the Five Step Model, JCM, or both when forming training courses and content to create a better environment to keep employees engaged in training. Best practices include mixing training delivery methods (classroom, online) and conforming content to match employee learning styles. In other words, training delivery should match individual employee competence levels [5]. Training documentation should include task rationale, task support, navigation, and have high usability and learnability. Usability is the ease of intended use, and learnability relates to the use of nontechnical terminology to ensure that instructions are understood [11].

EVALUATION

Every project or change should be evaluated and monitored to ensure that planned objectives are being met. Training is no exception. A useful training program evaluation should confirm that the program met its objectives of knowledge transfer, corporate strategy and business objectives, competitive advantage, organizational change, and organizational benefits [5].

THE CONSOLIDATION

Appropriate parties made the decision to consolidate a regional liberal arts university and a health sciences university to create a larger research institution with global reach. Community ties to each university ran deep prompting strong public reactions and in many ways division. As a result, life within the newly created university became fragmented as the Enterprise took over. Organizational authenticity became an issue early in the process and served to complicate the already delicate situation.

Regarding training, the fact that both institutions were using the same product appeared to make training easier. It would soon be discovered that employees in the smaller institution used the product much differently than the Enterprise. Additionally, the cultural and procedural differences were vast. Obviously, the Enterprise had much more bureaucracy which stifled productivity and increased frustration. The low morale caused by the lack of organizational authenticity and nature of the consolidation fueled training resistance. The framework used in training was very similar to the Five Step Model due to its simplicity. That was appropriate considering the training was not of a completely new ERP system.

Early on it was determined that there were few training topics in PeopleSoft necessary, although there was no pre-training assessment of the skills and needs of the users. The bulk of the vital training needed was in business processes and policies as the two institutions operated very differently. Training courses were scheduled during the summer with just a few sessions prior to

the July 1 fiscal year start date. The longest training was 4 hours in length and the shortest 1 hour. The schedule was set up to prevent too many classes from being given in one day. Presenters were very knowledgeable in their areas, however, they were not always able to translate the content to specific jobs. Training sessions were not department specific in most cases. Business processes presented were entirely new and required more of individual departments. They were also very general and seemed inefficient and ineffective. Change implementation without testing can be detrimental to the overall project implementation [16]. Policies were developed without the input of the end users leading to the belief that they were not properly tested prior to training.

Training was provided in-house and consisted of introductions, overviews, and light hands on opportunities. Introductions were of persons responsible for areas that users would need to interact with. That experience was positive because until then interaction with many of these contacts were via email only. The opportunity to meet them in person and converse provided assistance in bridging the trust gap between institutions. SAP modules reviewed in training included accounts payable, procurement, travel, reporting, payroll, and human resources. Training was not very effective mostly because of terminology and information overload. There was no variety in delivery methods as the classroom method was used. Training documentation was given with screenshots and contact information for people in various departments. Training documentation failed to include sufficient task rationale, have high usability and learnability, task support, and navigation. Additional training was available upon request and subject to availability of the trainer(s).

The applicable offices can be viewed as monitors of training of their particular modules; HR-PSHRMS, Financials-Financial Accounting office, etc. If there is an error in how a task was completed, these offices are responsible for ensuring the task is completed properly and that appropriate staff is notified of error and discussing correct procedure.

Evaluation forms were completed after each session, however, because the goal of training was to present the information to affected users, the objective was met irrespective of the deficient training. Knowledge transfer is typically the goal of training programs as opposed to knowledge exposure [2]. The trainers did thoroughly know their areas, but were not always able to translate to the different needs of users. In this situation, many of those processes were not developed. That was mainly due to the timeline of the merger. The Enterprise has a history of aggressive implementation timelines, however, this one was not self-imposed.

CONCLUSION

ERP systems are commonplace in the business world. They are only as effective as the employees who use the system correctly. To ensure proper usage, proper training must occur. Research revealed that employee trust is hampered by the lack of organizational authenticity in mergers

which made training much more difficult in the case study discussed above. Although the literature on ERP training in higher education mergers of institutions using the same ERP system is lacking, the research presented in this paper can be effectively applied to this case study. The application of appropriate andragogy techniques were not used in the development of this training program. While delivery methods were acceptable, terminology, customization, and documentation were not. As a result, employees were disengaged and appropriate knowledge transfer was not achieved. The aggressive timeline complicated matters further. The ongoing opportunities for training are the bright spot along with the caliber of the trainer conducting the majority of the training. Her inviting and understanding demeanor went far to appease employee mistrust. As employees dealt with the information overload, it was imperative that ongoing support was available. The increased scrutiny of the fiscal management of institutions of higher education demand accountability. The accuracy of the institution's financial statements rely on appropriate transactional processes that result from effective instruction and training.

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Defending the Value of Business Calculus/Calculus in the Curriculum of Bachelor of Science Business Degree Programs

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ABSTRACT

This paper examines the current question about the value of calculus in the curriculum being raised by business school programs at many 4 year institutions today. In a quest to streamline the curriculum, to improve completion rates, and be both timely and cost effective; a course historically required in many business programs is now being questioned as a necessity. Successful completion of traditional calculus or the application based calculus class offered in business programs combined with accounting and economics are essential courses required to advance to a degree program. While accounting and economics are not being questioned, calculus as a requirement is.

In today's information rich environment the skill set that our graduates require is always evolving. Ten years ago terms used today like "Big Data", "Supply Chain Management", "Differentiated target marketing", "Analytics" and etc., were not heard in everyday conversation in academic halls. What remains consistent is the need for our graduates to be prepared to capitalize on the demand of the market place.

INTRODUCTION

Corporations want their new employees to think outside of the box and be able to analyze and communicate effectively. Business calculus requires student to not only understand how independent variables (inputs) affect change resulting in a dependent outcome/ result but they need to know if the outcome is desired. They are required to make snap decisions based on primary analytical skills that are introduced and developed in a fundamental calculus class. Statistics is a higher evolved level of mathematics than college algebra/trigonometry and calculus can be considered a bridge between them. Although many students find Calculus and Statistics a challenge, no business leader can afford to personally or have his management team lack the ability to understand and recognize the potential advantage that comes with being able to analyze data.

In our global economy data is collected continuously in financial markets, political polling, engineering medical/pharmaceutical outcomes, and almost every area that affect daily life. Understanding the role of change and the ability to capitalize on the possibilities that change can bring in a global economy is the difference between a million dollar and a billion dollar portfolio. Collecting data merely documents/record change over time. Calculus is the fundamental study of change and the possible evolving outcomes. Studying calculus develop analytical and reasoning skills. This higher level of thinking is essential to understanding basic

statistics. Studying and understanding the data that is collected daily requires the use statistics.¹ Understanding probability, best fit, and confidence intervals are just some of the many statistical tools used in data analysis.

In the United States in 2013 only 39% (at or above 163/300) of high school seniors scored at a level that indicated that mathematically they was academically prepared for college.² Our pool of students includes a small portion of this 39 percent discussed above. Students that excel in basic math skills are better prepared to circumvent some of the academic pitfalls suffered by many. On many college campuses the field of Analytics is growing while the pool of students that are academically ready and prepared to do well in these programs is decreasing.

In the school of business most programs require fundamental levels of math and analytics that explain and define common business practices. Students, Administrators, Accreditation Boards, and the Federal Government are demanding and expect accountability for the programs and the classes taught in universities and colleges today. Students in the generation we are educating today are more apt to question the professor about the legitimacy of keeping calculus and statistics in the curriculum. Many feel that because there is not a clear path of thought between calculus/statistics and accounting, marketing, and business administration the courses should be deleted from the required curriculum. Professor's ability to transmit difficult topics³ in courses that require a lot of outside classroom commitment from students may not receive the reward deserved because of the correlation between difficult topics and outside commitment, usually result in lower overall grades.⁴

University administrators are demanding improvements in retention rates in programs that traditionally have high failure rates in foundation courses. Traditionally, in the business curriculum this included classes in accounting, business calculus, economics and statistics. Pressure to increase retention may result opting out when it comes to requiring these courses. Questions pertaining to the skill set of graduating seniors by potential employers have increased the demands for established criteria for assessment in all programs in higher education. This is an added layer to find a way to ensure that graduating college students share a fundamental measurable level of academic achievement.

OVERVIEW

- In an open forum we will explore some of the issues discussed above
- Compare/discuss the rigor /requirements currently used by the Author in this paper

All faculty, but especially new/junior faculty establishing their classroom curriculum may find this a great session to discuss and add their opinion about this issue. They can solicit and compare ways that their institution has incorporated calculus in their curriculum. Faculty charged with working on the curriculum for their school may use this as an opportunity to make comparisons or garner ideas that they can apply to their individual programs.

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Medical Demand Chain Performance and Treatment Service Levels for Wounded Military Personnel

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The early part of 2014 was marked by numerous new reports of long wait periods and quality of care issues for military personnel seeking medical care through the Veterans Administrations hospitals. Companies and the military have sought to streamline their supply chain or demand chain operations to improve performance and reduce cost. These strategic changes are pursued and implemented with the intent to benefit the organization and its customers.

Is it possible that a single or several links of that supply chain to achieve a high service level that negatively impacts subsequent links of that supply chain?

This paper will investigate the controversy or scandal related to the Veterans Administration delivery of medical care to wounded military personnel in the early part of the year 2014 as the final link in the military's demand chain that begins with military personnel being deployed to overseas combat arenas. In the wake of the news stories, audits have been conducted on procedures, response times, and levels of medical care extended to wounded military personnel by the Veterans Administration [1],[2].

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Have We Left The Barn Door Open?

An exploratory examination of data security in consumer grade bio-monitoring devices

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Abstract: As the number of consumer grade bio-monitoring devices on the market increases, it is important to examine what protections are being utilized by vendors to protect users' sensitive health-related information. Interviews with vendors of these devices suggest that data security is not a driving concern for the creators of many of the newest products coming to market.

1. Introduction

Technology is increasingly being amalgamated into a progressively translucent global health care industry. A press release by Technology Business Research, Inc. (2013) predicts that healthcare spending will surpass \$34.5 billion in North America in 2014. However, decreasing revenues and increasing regulation in the medical technology industry, coupled with reduction in research and development spending, are forcing companies to re-evaluate business strategies (Earnest and Young 2013).

To be competitive in the future, Earnest and Young (2013) predict that companies will need to cultivate or advance capabilities in relation to "open data enterprises" and "scalable process with appropriate metrics". The report goes on to indicate that companies will start to combine data streams from a variety of medical devices to gain efficiencies in cost, advantages in real-time management, and a more in-depth understanding of the overall health care picture for individuals and market groups. These predictions coincide with survey results from Gartner indicating that forty-one percent of the healthcare participants plan to invest in big data during the next two years (Gartner 2013). A report by PricewaterhouseCoopers (PWC) (2013) asserts that "social, mobile, analytics, and cloud technologies (will) prime (the) health (care) industry for new business models". These business models will integrate multiple applications and sensors to encourage a new ecosystem to improve health care. They go on to indicate that over half of the physicians and insurers in their study believe that extensive adoption of mobile health applications is inevitable in the immediate future.

Mobile bio-monitoring device applications in the health care market have the potential to significantly benefit both individuals and organizations. The devices include everything from smart-phone applications to smart watches that can monitor fitness and health data, to implants that measure glucose and proteins levels in the blood, to the use of Google glasses in medical environments (Evans 2013). This category also includes more traditional devices like pacemakers that have the ability to capture data and transmit it to other devices for future analysis and remote monitoring (Olshansky and Hayes 2013). The reality is that these devices have the potential to capture and transmit vast amounts of personal data about individuals. To complicate matters, a report by ECRI Institute highlighted data integrity failures in electronic health records and other health IT systems in their Top Ten Healthy Technologies Hazards for 2014 report (ECRI Institute 2013). The mobile technical evolution of the healthcare industry prompted several research questions: Is data being retained in mobile bio-monitoring devices? If data is retained, for how long is it being held on the device? If it is being retained, is the data on the device secured? What, if any, steps are bio-monitoring device vendors taking to adequately protect the valuable data their devices collect?

This paper is structured as follows: Section two discusses related work concerning mobile device security and privacy. Section three presents the methodology and summarizes the artifacts recovered. Section four provides a discussion of the results. Section five draws conclusions and presents future work.

2. Related Work

Many consumer grade bio-monitoring products are the result of the marriage of two different streams of technology: mobile smart devices (e.g. smartphones and smart watches) and professional grade bio-monitoring devices used in healthcare. While the findings of recent studies on each of these constituent technology streams suggest that user data is not being adequately protected, the partnering of the two technologies brings a number of new concerns regarding the protection of user data.

The security of medical devices, especially those that are implanted inside the body, has been a very active area for research in the last few years. Researchers have shown that gaining unauthorized access to devices like implantable pacemakers, defibrillators, and insulin pumps pose little challenge to someone with a desire to access them (Gollakota et. al, 2011). Specialized equipment to communicate with older implantable technology is commonly available on eBay and from other sources as hospital surplus. Newer implantable devices often use common communication standards such as Wi-Fi and Bluetooth and can be accessed using off-the-shelf equipment.

Research on the data security protections embedded in mobile smart devices is just as worrying. A study by Glisson et al. (2011) of mobile devices obtained from the secondary market found large amounts of residual data left from the original user. A second study (Glisson and Storer 2013) that looked at mobile smart devices that had been returned by employees of a Fortune 500 company similarly found a large amount of residual data left on the devices.

3. Methodology

In order to address the research questions in this study, a three person research team interviewed 13 vendor representatives displaying a total of 94 bio-monitoring devices at the 2014 Consumer Electronics Show in Las Vegas, NV. The research team consisted of a PhD in Information Systems, a Registered Nurse with a Master's degree in Nursing Informatics, and a Health Informatics undergraduate student. Almost all vendors were promoting multiple consumer grade bio-monitoring devices. The majority of vendor representatives interviewed were upper management (CEO was most common), but all held a management position in the company.

For each interview, the research team would inform the vendor representative that the point of the interview was to collect data on device security and residual data. Specifically, vendor representatives were asked about the types of data collected by each of their devices and where it was stored. Although the researchers did not ask specifically about the vendor representative's opinion of the sensitivity of the data collected by these devices, all of the vendor representatives interviewed did touch on this issue to explain the protections (or lack of protections) that their devices utilized.

4. Results

The 94 bio-monitoring products offered by the vendors interviewed record a wide array of data including:

- Activity tracking (steps taken or miles traveled by bike)
- Blood glucose
- Blood pressure
- Body fat
- Body temperature
- Body weight
- Electrical activity of the heart (ECG)

- Electrical activity of the brain (EEG)
- Heart rate/pulse
- Location
- Sleeping patterns

An analysis of our discussions with these vendor representatives revealed a number of interesting findings. These findings are discussed in more detail below.

- Devices that store data locally generally do not include protection schemes (e.g. data encryption or authentication).
- Devices that store data on a connected device (e.g. a Bluetooth enabled smart phone) generally rely on the security embedded in the operating system of that device to protect data and do not include additional safeguards in their software.
- Devices that store data remotely did so on a remote server operated by the vendors themselves.
- Devices that stored data on a connected device or on a remote server generally retained the data indefinitely unless constrained by storage requirements.
- Most representatives that we spoke with did not consider the data that their devices collected to be of much interest to anyone except the individual that it was collected from or their physician.

Devices that store data locally generally do not include protection schemes (e.g. data encryption or authentication). Since these devices contain no security, it would be easy for someone to retrieve personal data if they had access to the device. The representatives of devices that fell into this category did state that data was stored in a proprietary format that would be difficult to make sense of outside of the application, but we were unable to verify this claim. A mitigating factor is that since these devices generally are not "connected" to any other device, data cannot be remotely accessed; therefore, data breaches impacting more than one person would be very labor intensive.

Devices that store data on a connected device generally rely on the security embedded in the operating system of that device to protect data and do not include additional safeguards in their software. These operating systems (Android and iOS were the most common) are not necessarily secure, especially if the user does not activate the embedded security features. The connected nature of these devices makes them vulnerable to remote attack which makes harvesting the health data of large numbers of individuals possible. A mitigating factor would be the need to infect a large number of connected devices with malware in order to harvest user data on a large scale. Most of the vendors we spoke with sell a range of bio-monitoring devices that each record a different type of data. The connected device then assembles the data from all of the bio-monitoring devices to create a holistic assessment of "wellness". This holistic dataset is more valuable to the user, but also to the outsiders, than any single data point from a single bio-monitoring device.

Devices that store data remotely did so on a remote server operated by the vendors themselves. While many larger companies do exhibit at the Consumer Electronics Show, the majority of the companies we spoke to were smaller startups who were at the conference to pursue agreements with distributors. Smaller companies with limited budgets may not have the resources to adequately protect their servers from outsiders who may wish to access the data contained on them. While we were not able to assess the security measures of the individual vendors' servers, it is a concern that small companies who internally perform tasks outside of their core competencies (such as network security) may not be as thorough as a company with skills in this area.

Devices that stored data on a connected device or on a remote server generally retained user data indefinitely unless constrained by storage requirements. Devices that stored data locally on the device generally retained a smaller number of data points, but still enough to let the user evaluate their data over a significant period of time. Overall, we noted a general lack of company policy related to data retention.

While retaining larger amounts of data can provide value to the user, it also provides a more appealing target to outsiders.

Most representatives that we spoke with did not consider the data that their devices collected to be of much interest to anyone except the individual that it was collected from and their physician. Although, the possible uses of bio-monitoring data is a topic that requires additional study, we believe this data could be valuable to many groups including insurers (both health and life), employers, drug companies, product marketers, data aggregators, and governments. It is quite possible that other more nefarious uses could also be devised. In fact, at the present, there does not appear to be any legislative roadblock in most states to vendors sharing or selling this information with others since these vendors would not be considered covered entities under the Health Insurance Portability and Accountability Act (HIPAA).

5. Conclusions and Future Work

The results of the exploratory study described in this paper provide preliminary support for the hypothesis that non-secure residual data is being stored in mobile bio-monitoring devices, connected devices, and remote servers. Potential data leakage in this context is no longer strictly a matter of technical design; it has the potential to have serious consequences on people's lives. The interviews specifically revealed that management may not fully understand the value and sensitivity of the data being collected and, therefore, may not be taking adequate measures to protect it.

The study provides a foundation for a more extensive real-world examination of consumer grade bio-monitoring devices using forensics tools and approaches as a mechanism for data extraction. Future research should investigate bio-monitoring devices in real-world environments in order to understand how and where data is being stored, and to visualize and compare datasets. The ultimate goal is to identify criteria and investigate the development of algorithms to predict future health issues with a high degree of certainty based on user data recorded in these devices. Another research direction is to investigate the forensic examination of data stored in implantable medical devices that have been encountered during an autopsy. The idea is to ensure that the data retrieved from the device does not contradict the medical examiner's analysis.

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