Identifying the Critical Success Factors for Information Systems to Manage Sponsored Research Activities at Institutions of Higher Education

Dwayne Lehman
lehman@rmu.edu
Information Systems and Communications

Connie Ruzich
ruzich@rmu.edu
English

Robert Morris University
Moon Township, PA 15108, USA

Abstract

Sponsored research at an institution of higher education is big business and requires an appropriate information system to meet the sponsor's fiscal and regulatory compliance standards. This research sought to identify the critical success factors for an information system to manage sponsored research at an institution of higher education and determine if there were perceived differences in the factors between department/college level and central/university level research administrators. A Delphi panel of expert research administrators with more than eight years of experience in the field of research administration who worked for highly ranked research colleges or universities (according to the Carnegie Classification) identified six critical success factors needed to manage sponsored research at an institution of higher education. The findings indicate the need for continuity of information throughout the lifecycle of a sponsored project and the integration of existing organizational information systems to manage sponsored research. These factors are important for institutions of higher education as they replace legacy systems and implement new enterprise systems to manage sponsored research. Although there were no statistically significant perceived differences of information system success factors between department/college and central university research administrators, several trends were identified. One trend identified was that department/college-level research administrators desired more financial tools to aid them in the budget development and expenditure forecasting of sponsored projects over what central/university-level research administrators indicated. A second trend identified was that department/college-level research administrators were less concerned about the technical aspects of an information system in comparison to central/university-level research administrators.

Keywords: Delphi technique, information systems, critical success factors, system integration, university research administration.

1. INTRODUCTION

Research is an integral part of the post-secondary education institution mission and represents a significant portion of all activity on college and university campuses. This study focuses on the administration and management of research activities conducted at colleges and

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universities. Whereas faculty members, research scientists, and other academic personnel lead these efforts of investigation, innovation, and exploration to expand understanding of the world and develop new products and ideas, research administrators assist investigators by managing the non-scientific elements of this work. The administration of these research activities requires suitable information systems to perform the tasks related to proposal submission, contracting, personnel and financial management, and regulatory compliance. Determining the necessary elements of this information system is essential to the overall success of the research enterprise, particularly the research administrator's job of facilitating the investigator's research and the institution's adherence to applicable laws and regulations.

The purpose of this project was to determine the critical success factors necessary for an information system (IS) to effectively manage sponsored research activities at all levels within institutions of higher education. Critical Success Factors are the select areas that are essential for the success of the person, unit, or organization (Bullen & Rockart, 1981). These factors determine the health and vitality of the organization and require the manager's continual attention, support, and evaluation in order to achieve goals (Caralli, Stevens, Wilke, & Wilson, 2004; Paramenter, 2007). This project also aimed to determine if there are perceived differences between department/college level research administrators and central/university level research administrators in the necessary factors for an information system. This research adds to the body of knowledge by applying the critical success factor theory to identify the necessary factors for an information system used by research administrators within higher education to manage sponsored research. As new information systems are implemented or existing ones upgraded within an organization, the establishment of these factors will be important in designing, choosing, and evaluating these systems. The critical success factors essential for an information system to properly manage sponsored research have not been previously identified.

The administration and management of sponsored research at an institution of higher education is a multifaceted task that spans across an organization. The information system needed to serve the research administrator's needs is equally complex. A Delphi technique was used to capture and identify the critical success factors necessary for an information system to manage sponsored research across all levels of research administration within an organization. This methodology is appropriate for researching complex issues "where large scale quantitative hard data fails to unearth the richness in tacit knowledge to help the research understand subtle expert opinion" (Grisham, 2009, p. 112). The Delphi research methodology leverages the knowledge and experiences of a select group of experts or qualified professionals to obtain a consensus on multifaceted issues through an iterative process.

This research project is limited in scope. Only institutions of higher education located in the United States (US) were examined. Other types of organizations that conduct sponsored research were excluded. This field project focused on the information systems available for the management and administration of research activities at an institution of higher education administration and does not include a discussion of electronic research administration (ERA) tools and products provided by sponsoring agencies. Although these institutions of higher education may use other information systems related to managing financial data, human resources, and student information, these systems were not evaluated. Lastly, this study focused on the end-user of the information system, the research administrator who is responsible for the administrative management of research activities within the organization. Other groups such as faculty, scientists, and other members of the organization holding administrative positions were excluded.

2. SPONSORED RESEARCH IN HIGHER EDUCATION

For the purpose of this research project, sponsored research refers to a written formal agreement entered into with external agencies that drive the financial resources of these research efforts. These agreements may appear in the form of grants, contracts, cooperative agreements, gifts, and other types of financial mechanisms (Office of Management and Budget, 2004). Each agreement that provides funding for academic research may also contain specific regulation and compliance terms and conditions. The primary agencies that provide research funding to colleges and universities include the federal government, state and local governments, private businesses, and non-profit foundations (National Science Foundation, 2015).

Sponsored research at colleges and universities is big business. According to the National Center for Science and Engineering Statistics (NCSES), universities spent over $67.3 billion on research and development in 2014, a 0.2% increase from 2013 (National Science Foundation, 2015). Research activities can bring prestige to a university or college and increase its competitive rankings and assessment (Turk-Bicakci & Brint, 2005). As a result, institutions of higher education are including research agendas as a major part of the organization's strategic plan and are seeking out new partnerships with corporations, governments, and non-profit foundations to grow their reputation (Derrick & Nickson, 2014; Turk-Bicakci & Brint, 2005). Leaders of higher education institutions are also promoting and developing more complex research strategies that include interdisciplinary, intercollegiate, and international collaborations to promote academic excellence and increase recognition and ranking (Langley & Huff Ofosu, 2007; Rutherford & Langley, 2007).

While sponsored research is vital to many higher education institutions, federal research funding is declining and is subject to tighter compliance and fiscal controls. In fiscal year 2014, the federal funding for higher education research and development dropped 5.1% after adjusting for inflation (National Science Foundation, 2015). The National Center for Science and Engineering Statistics (NCSES) reports that federal research funding to institutions of higher education fell more than 11% since 2011 and "this is the longest multiyear decline since this data started to be collected in 1972" (National Science Foundation, 2015, p. 1). Additionally, while the National Institutes of Health (NIH) reports a 40% increase in the number of research applications received since 2003, its amount of research funding has remained fairly level (Kulakowski E. C., et al. 2007). This has led to a reduction in NIH funding of all submitted research proposals from the 30th percentile range down to the 10th percentile range (Kulakowski E. C., et al., 2007). This decline in sponsored research has impacted a significant number of very high and high research institutions classified according to the Carnegie Classification of Institutions of Higher Education.

In addition, regulatory and reporting requirements by sponsoring agencies have also increased. Smith, Trapani, Decrappeo, and Kennedy (2011) state, "whereas the cost of each individual regulation may not appear to be significant, the real problem is the gradual, ever-increasing growth or stacking of regulations" (p. 57) hindering the investigator's productivity and increasing the administrative requirements of performing research. These factors have also affected the amount of time researchers can dedicate to performing research. In the 2012 Faculty Workload Survey, Schneider, Ness, Rockwell, Shaver, and Brutkiewicz (2012) report that, "researchers spend approximately 42% of their research time focused on administrative tasks such as proposal preparation, preawared and post award administration and report preparation for federally sponsored research projects instead of actually conducting research" (p. 6). Even with adequate research administration assistance, researchers stated that the administrative requirements for sponsored research projects would still consume 31% of their time (Schneider, et al., 2012).

Sponsored research is growing both in terms of the complexity of the research being conducted and in terms of the fiscal, regulatory, and contractual requirements set by sponsoring agencies. Increasing competitiveness for limited sponsored research funding adds to the complexity of managing sponsored research in higher education. The administration and management of these sponsored research activities requires a robust information system. The information systems needed to support research administration require increasingly complex project management structures and methods in order to meet demand (Rutherford & Langley, 2007). There is a critical need to better understand the essential elements of an information system that can efficiently manage the administration of sponsored research.

3. RESEARCH ADMINISTRATION

The administration of research conducted at institutions of higher education represents the business support necessary for the success of any exploratory initiative (Kulakowski & Chronister, 2006)**.** The increased competition for limited research funding, combined with the sponsors' demand for tighter fiscal accountability and reporting requirements, has expanded the role and responsibilities of the research administrator (Lintz, 2008). Today research administrators (RA) are fully integrated throughout all levels of the organization, perform a diverse collection of duties and require a working knowledge of the legal, ethical, scientific, and fiscal components of academic research (Lintz, 2008; Shambrook & Roberts, 2011). Figure 1 (Appendix A) illustrates

the various roles and responsibilities of research administrators.

The administration of a sponsored project can be categorized into two primary areas: pre-award and post-award (Kulakowski & Chronister, 2006; NCURA, 2015). The pre-award project activities include finding funding, proposal development, proposal submission, award negotiation, and project setup (Campbell, 2010; Kulakowski & Chronister, 2006; NCURA, 2015). The post-award administration activities include accounting, accounts payable and receivable, property and inventory control, payroll and reporting (Campbell, 2010; Kulakowski & Chronister, 2006; NCURA, 2015). Dependent on the amount of research conducted at an institution of higher education and the organizational structure of personnel and authority, and research administration function, research administration can be further divided into two general groups: research administration and management at the university or central level, and the administration and management of research that operates at the department/college level (Campbell, 2010). The central-level research administrators primarily have an external focus and a broadly defined responsibility to ensure that the institution promotes excellence in the conduct of research (Galland, McCutcheon, & Chronister, 2008). These research administrators represent the organization and are primarily concerned with compliance (NCURA, 2015). The department/college-level research administrators are typically more internally focused and are primarily concerned with the direct support of the researcher, the responsibilities of others working on the project, and the academic department to which the researcher is assigned (Campbell, 2010; Kulakowski & Chronister, 2006; NCURA, 2015). The identification of critical success factors for an appropriate information system is essential to the overall success of the administrator's job performance, the facilitation of the investigator's research, and the regulatory management of the institution.

4. CRITICAL SUCCESS FACTOR THEORY

The Critical Success Factor Theory was first introduced and applied to the field of information systems by John Rockart (1979) in the *Harvard Business Review* (HBR) article "Chief Executives Define their own Data Needs" based on D. Ronald Daniel's 1961 article "Success Factors" (Rockart, 1979 p. 85). Rockart defined critical success factors as:

> The limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department or organization. Critical success factors are the few key areas where 'things must go right' for the business to flourish and for the manager's goals to be attained (Bullen & Rockart, 1981, p.7).

Rockart initially developed the critical success factor (CSF) theory as a management information system (MIS) planning tool to identify and communicate a manager's information requirements (Boynton & Zmud, 1984). These management-identified factors or elements are vital to the organization's evolution and must receive constant attention, support, and evaluation. The primary advantage of the critical success factor (CSF) theory is that it communicates and makes explicit the major concerns of management, thus reducing organizational ambiguity (Boynton & Zmud, 1984; Caralli et al., 2004). Paramenter (2007) states, "Better practices suggests that there should be only between five and eight CSFs" (p. 29). The critical success factor theory is an established information systems tool to discover and communicate the information system requirements at various managerial levels. This study focuses on applying the critical success factor theory to a profession (research administrators) within the industry of higher education.

5. METHODOLOGY

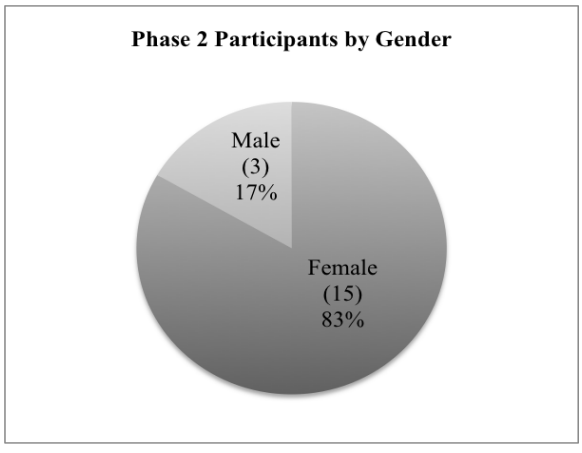

Figure 1: Phase 2 participant gender

An exploratory sequential mixed-methods research strategy was used for this project. The data collection method followed a modified e-Delphi technique for ranking-type surveys and consisted of two phases (Keeney, et al., 2011). Both phases were conducted through an on-line survey. The initial, qualitative phase sought to discover the issues, and aimed to gather consensus around the most important issues (Keeney, et al., 2011; Schmidt, 1997). The subsequent stages sought to prioritize or rank these issues (Abu, et al., 2012; Schmidt, 1997).

The Delphi research methodology leverages the knowledge and experiences of a select group of experts or qualified professionals to obtain a consensus on multifaceted issues through an iterative process. This methodology is appropriate for researching complex issues "where large scale quantitative hard data fails to unearth the richness in tacit knowledge to help the research understand subtle expert opinion" (Grisham, 2009, p. 112). There are four goals associated with a Delphi study: (1) gather and summarize knowledge from an expert panel, (2) obtain an agreement or consensus in regard to the topic or issue, (3) explore ideas with knowledgeable participants, and (4) provide information to aid in decision-making (Abu, Ritchie, & Jones, 2012). The Delphi Method is systematic, flexible, and allows for the use of a variety of communication methods and tools (Abu, et al., 2012; Dalkey, 1969). It is also insightful and produces reliable and valid results (Abu, et al., 2012; Dalkey, 1969; Grisham, 2009).

A purposive sampling technique was employed for this study. A study utilizing the Delphi technique can have any number of participants. The ideal sample size of experts is large enough to represent the population, conduct the desired research, and yet remain manageable by the researcher (O'Leary, 2014; Williams, 2004). Okoli and Pawlowski (2004) recommend an expert panel size of between 10 and 18 participants (p. 19). The participants for this study consisted of research administrators (RA) from Very High and High Research Institutions, as identified by the Carnegie Classification of Institutions of Higher Education, and participants were required to have a minimum of eight years experience in the field of research administration; they had to be familiar with both pre-award and post-award research activities, and they were required to be currently using an institutional information system to manage sponsored research.

The Delphi panel consisted of 18 people. Fifteen females and three males completed both surveys (Figure 1). The gender percentages for this Delphi study are consistent with the 2010 Profile of a Research Administrator (Shambrook & Roberts, 2011). Sixty-seven percent of the participants had 17 or more years in the field of research administration and 33% had between 8 and 16 years of RA experience.

RAs working at the central/university level represented 78% and department/college level RA represented 22% of the Delphi panel (Figure 2). According to the 2010 Profile of a Research Administrator, 30.3% of research administrators identified themselves as working at the department level (Shambrook & Roberts, 2011).

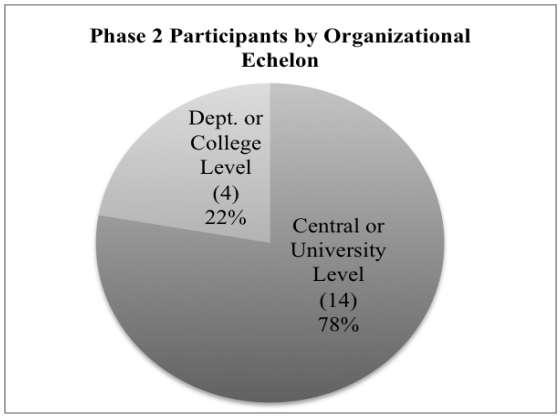

Figure 2: Phase 2 participant organizational

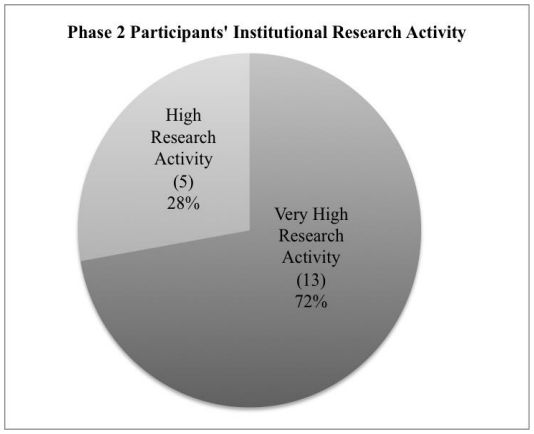

Figure 1: Phase 2 participants' institutional research activity

One limitation of this research is that the number of participants identifying themselves as department/college level research administrators did not match the 2010 RA profession profile; over representing research administrators at the

central/university level. Seventy-two percent of the participants worked at Very High research institutions, while 28% indicated they worked at an institution with High research activity according to the Carnegie Classification of Institutions of Higher Education. Tables 1 and 2 indicate the state and institutional control of the institutions the Delphi participants identified as working for.

Table 2: Carnegie Classification High research institutions from the following states were represented

Table 3: Carnegie Classification Very High research institutions from the following states were represented

6. RESULTS AND DISCUSSION

Phase 1 survey results

Upon completing the analysis of the Phase 1 survey results, the following 22 factors (Table 4, Appendix A), listed in the order of frequency, were identified as being critically important for an information system to manage sponsored research at an institution of higher education.

Very High Research Institutions	
High Research Institutions	
State	**Control**
State	**Control**
California	Private not-for-profit
Alaska	Public
California	Public
California	Public
Florida	Public
Illinois	Private not-for-profit
Kentucky	Public
Maryland	Public
Maryland	Private not-for-profit
Mississippi	Public
Massachusetts	Private not-for-profit
North Carolina	Public
Montana	Public
Ohio	Public
Oklahoma	Public
Pennsylvania	Private not-for-profit
Pennsylvania	Public

Additionally, the most common theme that emerged was the issue concerning the efficacy and number of information systems used to manage sponsored research. Eighty percent of the department/college level research administrators and 59% of central/university level research administrators indicated that separate, nonintegrated, and inadequate information systems were the most frequent problem or obstacle in the management of sponsored research. The use of proprietary or homegrown information systems was prevalent among the Delphi panel. Fifty percent indicated the use of an organization-created information system(s) to meet their needs. Twenty-seven percent stated that they used a shadow system in addition to the information systems provided by the institution. For the purposes of this research, a shadow system is defined as any spreadsheet application or database that replicates data and functionality of an organizational information system to address the deficiencies of the existing information system (Behrens, 2009). Lastly, the participants indicated that the problems with research administration information systems spanned the lifecycle of sponsored research from pre-proposal development, through award set-up and post-award management, to reporting and project closeout.

Phase 2 survey results

Six of the 22 factors identified by the Delphi panel participants for an information system to manage sponsored research activities at an achieved greater than a 50% majority, had a mean greater than 4.40, had a standard deviation of less than 1.00, and attained an IQR of 1.00 or less. One of the goals of the Delphi methodology is to obtain consensus among the participants, these qualifying measurements were chosen because they indicate a high level on consensus within the Delphi panel. Those factors were

1. Must be accessible through the Internet/Intranet
2. Must have top leadership support
3. Must be easy to use (user friendly) for different users at all levels
4. Must work and integrate across existing institutional information systems and platforms
5. Must have dedicated, continual IT support
6. Must be able to attach, store, and retrieve supporting documentation

Two of the six critical success factors needed for an information system to manage sponsored research (must work and integrate across existing institutional information systems and platforms and must be able to attach, store, and retrieve supporting documentation) were related to the data management functionality of an information system. The first CSF in this category was the ability to work and integrate across existing institutional information systems and platforms. Dowdy and Schultz (2015) provide a possible explanation for the lack of system integration by stating,

> Generally speaking, yesterday's legacy systems were often stovepipe applications. That is, the pre-award

> system met the needs of the pre-award office but had little or no interaction with the financial system. The financial system had little to no interaction with the human subjects system or the intellectual property system. In effect, each ERA process was a stand-alone application, developed over time, to satisfy a particular business processes or transaction (p. 905-6).

Data management functionality is also key in the sixth ranked CSF: the ability to be able to attach, store, and retrieve supporting documentation. The amount of documentation and records generated from pre-award proposal development through contract negotiations and award set-up to project closeout is substantial. A single document repository might logically increase efficiency and improve communication. Sponsored research projects can have durations ranging from a few months to a decade or longer. The importance of capturing the continual flow of documentation and information for a sponsored project throughout its lifecycle in a single information repository could prevent the loss of information through personnel transition and turnover, and aid in the accuracy, timeliness, and completeness of project reporting.

The 4th ranked CSF, that of being easy to use (user friendly) for different users at all levels, and the 1st CSF, that of being accessible through the Internet/Intranet, were related to the user interface of the information system. Ease of use focuses on the end-user requirement for the information system, which is consistent with the rules of user-centered design (Norman, 1988). Finally, organizational factors were key to two CSF's and ranked 2nd and 5th. The participants considered reliability and consistent operational access to the sponsored projects information system the top priority through the existence of continual, dedicated IT support. This is consistent with the participants' concern for information system reliability and demonstrates their dependence on information systems to perform the duties associated with research administration. The other organizational factor considered critical was the support from top leadership. Top leadership support can be interpreted as support from the President, Provost, or Vice-Provost of the institution to provide funding and resources in the investment, maintenance, and upgrade of research administration information systems. However, it can also be interpreted as the advocacy, moral encouragement, and championing of the research administrator and the important contributions of his/her work to the research mission. Further research is needed to clarify the role top leadership plays in sponsored research administration.

The cross-tab analysis of Likert-type scale responses to the 22 factors did not yield any statistically significant findings between the central/university-level and the department/college-level of research administrators. When the comparing the ranking of extremely important factors between the two groups were compared, no statistically significant findings were found; however, several trends were discovered. On average, department/college level participants ranked three specific factors in the top 5 more frequently than central/university level participants on the Likert-type scale. The factors include the following:

- Must provide budget forecasting tools
- Must provide budget-development tools
- Must provide automated effort certification reporting tools

One hundred percent of the department/college level participants indicated that budget forecasting tools were *extremely important* or *very important* for an information system to manage sponsored research. However, only 35.7% of the central/university level participants indicated this factor as either extremely or very important. Likewise, 75% of the department/college level participants indicated that a budget development tool was extremely important for information systems managing sponsored research. Only 14.2% of central/university level participants indicated this factor was extremely important. One possible explanation for this trend is that department/college level research administrators work more closely with faculty researchers and often prepares the project budget for the proposal submission based on the researcher's guidance.

Department/college level participants had a tendency to be less concerned about the technical aspects of information systems used to manage sponsored research. Again, there were no statistically significant findings. When the ranking of extremely important factors was compared, the following five technical factors for an information system to manage sponsored research were observed to be consistently ranked as less important for department/college level participants than for central/university level participants:

- Must be able to expand capabilities based on institution needs

- Must be easy to update based on policy and regulation changes
- Must provide continuity of information from pre-award proposal development through post award management
- Must be accessible through the Internet / Intranet
- Must have dedicated, continual IT support

One possible explanation for this observation is that typically the Vice President of Research, or its equivalent title, is a central/university level position and it is this position that is responsible for the research administration systems and technology used at an institution (NCURA, 2015). Department/college level research administrators may accept a fatalistic perspective with regard to the technical capabilities of an institution's information system to manage sponsored research.

The need for ERP ERA

The data suggests that an enterprise-level information system solution to manage sponsored research at an institution of higher education could be advantageous. Two of the critical success factors are related to the integration and communication of information across an institution of higher education (must work and integrate across existing institutional information systems and platforms and must be able to attach, store, and retrieve supporting documentation). Additionally, three factors were determined by the Delphi panel to be *extremely important* and achieved a greater than 50% majority, but not considered critical to the management of sponsored projects also address the need for system integration. The three factors that promote the adoption of an integrated ERP are as follows:

1. Must provide continuity of information from pre-award proposal development through post award management
2. Must be able to provide data analytics for robust and flexible reports at all levels across the organization
3. Must be able to monitor and track compliance requirements (IRB, IACUC, COI, etc.)

From an administrative perspective, the need for system integration for a research administration information system seams clear: 86.4% of the participants indicated that they use one to nine separate systems, and on average, participants reporting using 3.13 separate information systems to perform their duties as research administrators. Additionally, 27% of the participants indicated that they use a shadow system in addition to organization-provided systems to perform their jobs. Implementing an enterprise resource planning (ERP) for the administration of sponsored research has the possibility of decreasing the redundancy of data entry, as well as improving administrator efficiency and accuracy.

From a business perspective, the proper and effective management of sponsored research is critical to the financial sustainability and success of the institution. For example, at Carnegie Mellon University (CMU) sponsored research makes up 33.9% of the annual operating revenue (Carnegie Mellon University, 2015). Likewise, the University of California (UC), a large, public state university system with numerous campuses that includes UC Berkley, UC Davis, UC Irvine, UC Los Angeles, and others, received approximately $5.44 billion in sponsored research funding in fiscal year 2014, which represents slightly over 20.4% of their annual revenue (University of California, 2015). Given the significant percentage of operating revenue generated from sponsored research for the Carnegie Classification Very High and High research institutions, an ERP-level information system is recommended.

Challenges of ERP implementation

The implementation of an ERP research administration system is a challenge for institutions of higher education. The major challenges for these institutions are providing the dedicated financial infrastructure and human resources necessary to accomplish the ERP implementation. Electronic Research Administration (ERA) systems require a substantial initial capital investment from the organization and continued monetary support for the maintenance and upkeep of the ERP system. Additionally, the ERP system will require significant time to phase out existing legacy systems, train staff and faculty on the new system, and design and adopt new business processes.

The organizational culture is also a major challenge with implementing an ERP system at institutions of higher education. Colleges and universities are predominately structured in silos (Chisita & Abdullahi, 2012; Evans & Malina, 2010; Kolowich, 2010). For the purposes of this study, a silo is defined as an organizational structure that promotes departmentalization and specialization within different units of the organization (Chisita & Abdullahi, 2012; Evans & Malina, 2010; Kolowich, 2010). One reason for

this phenomenon is that it promotes a "strong college model . . . which emphasizes the individual brands of different colleges on a campus [and] empowers those schools to attract talented scholars and funding for important research in their particular disciplines" (Kolowich, 2010, p. 1). However, this structural model also creates communication, interdisciplinary research, and information technology challenges (Kolowich, 2010).

Another cultural challenge is the actual value and importance leadership places on research administration within the organizations. The use of multiple proprietary and legacy systems used to manage sponsored research suggests a possible disconnect between the espoused value concerning the importance of research administration and the actual actions leaders take to support and champion the administrative tasks associated with sponsored research. The lack of dedicated resources to support the implement an ERA system could indicate a divide between espoused values and lived values. The benefits of implementing an enterprise-level ERA information system have the ability to lessen the obstacles associated with the archetypal departmental structure of colleges and universities and promote more effective communication, knowledge sharing, and cross-disciplinary institutions.

7. CONCLUSION

Sponsored research at an institution of higher education is big business. This research focuses on applying the critical success factor theory within the industry of higher education to identify the critical success factors for the information systems used by research administrators professionals at all levels within the organization to successfully manage sponsored research. This study identified six critical success factors for an information system to manage sponsored research at an institution of higher education. Although no clear statistically significant findings were evident between department/college level and university/central level research, administrator information system needs were identified and several trends were observed. The list of identified critical success factors should not be considered exhaustive, but rather viewed as a door to other research opportunities in the research administration profession and higher education information systems.

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Appendix A

Strategic	Policy	Operational
Research strategy	Research Ethics	Proposal development
Research theme development	Research governance and integrity	Budgeting
Portfolio management	Reporting	Proposal submission
International research	Intellectual property	Contract negotiation and monitoring
Trend analysis	Technology transfer	Post award financial management
Business development	Start-ups and commercialization	Project Management
Risk assessment and monitoring	Auditing	Clinical trials and research
(Adapted from Langley & Huff Ofosu, 2007; Lintz, 2008; Kulakowski & Chronister, 2006)		

Table 3: Duties and Responsibilities of research administrators

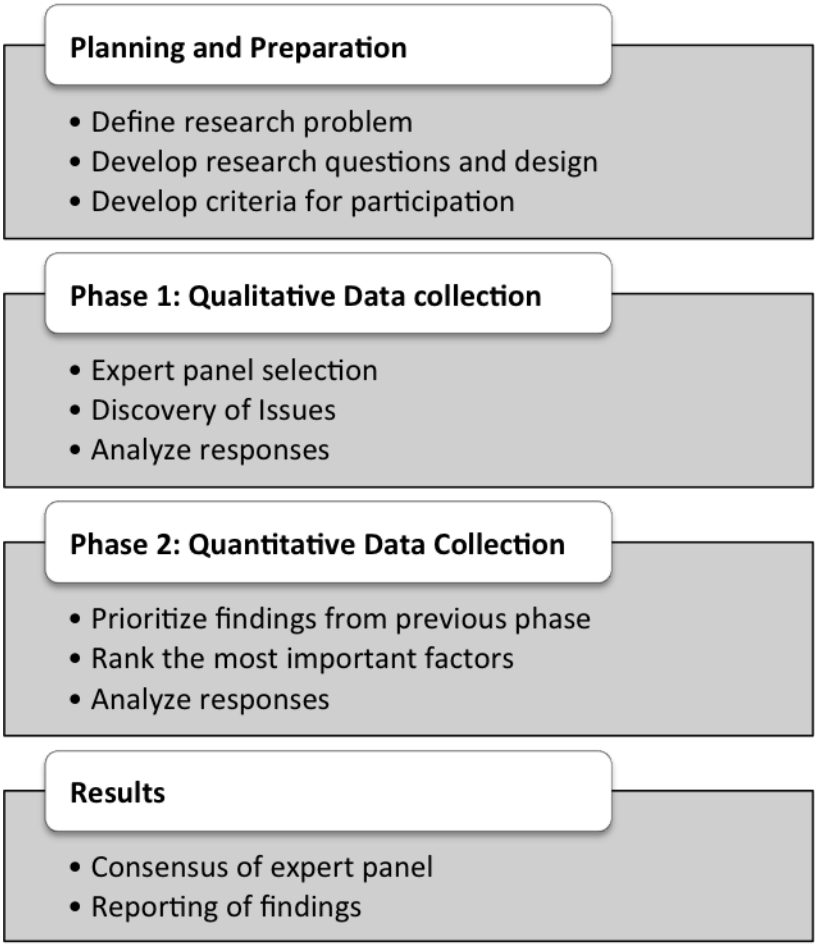

Figure 4: Research design

1	Must be able to provide data analytics for robust and flexible reports at all levels across the organization
2	Must be easy to use (user friendly) for different users at all levels
3	Must provide automated error checking of proposals to ensure compliance
4	Must work and integrate across existing institutional information systems and platforms
5	Must have dedicated, continual IT support (either in-house or provided by vendor)
6	Must be able to expand capabilities based on institution needs
7	Must provide continuity of information from pre-award proposal development through post award management
8	Must be capable of electronic proposal submission to prime or sponsoring agency (system-to-system capability)
9	Must be able to monitor and track compliance requirements (IRB, IACUC, COI, etc.)
10	Must provide electronic processing of proposal applications (Internal Routing and approvals)
11	Must be easy to update based on policy and regulation changes
12	Must be accessible through the Internet / Intranet (web-based or web enabled)
13	Must be able to link to sponsor or prime agency regulation and guideline references
14	Must have an alert mechanism to identify upcoming proposal deadlines, budget and expense variances, and compliance requirements
15	Must be able to attach, store, and retrieve supporting documentation
16	Must provide budget development tools
17	Must provide real-time expenditure tracking
18	Must provide budget forecasting tools
19	Must be able to provide customized dashboards for all users
20	Must provide automated effort certification reporting tools
21	Must be able to monitor and track sub-awards
22	Must have top leadership support

Table 4: 22 Factors for an information system to manage sponsored research at an institution of higher education