The Impact of a Focus on Change in Technology in Successful Implementation of SAP Enterprise Resource Planning Systems in North and South America

William Stewart Thomas
University of North Carolina at Pembroke

Danielle Babb
American Public University System

John E. Spillan
University of North Carolina at Pembroke

Organizations find the adoption of Enterprise Resource Planning (ERP) as a necessity to enhance success of focus on multiple competitive priorities. With the adoption of ERP comes the potential for success as well as failure. While studies have been conducted on the impact of change management and change to best business practices, the impact of focus on technology and the related correlation to successful ERP implementations remains in question. This research measures the impact of technology as correlated to successful ERP implementations in hopes to contribute to scholarly findings and advice to future practitioners for future success in ERP implementations.

INTRODUCTION

Enterprise Resource Planning (ERP) applications are the most popular means of overall business process improvement since the North American adoption of the Japanese led concept of Just-in-time (JIT) management and inventory control in the 1970's (Oliver & Romm, 2002). Successful ERP systems can provide the backbone of business intelligence for an organization. This gives management a unified view of its processes and better enables control over those processes (Gale, 2002).

ERP systems are cross-functional enterprise systems driven by an integrated suite of software modules that maintain the central internal business processes of a company giving an integrated real-time view of core business processes. These modules operate interactively utilizing one database which shares all information necessary for each module's purpose, as well as user requirements (Scalle & Cotteleer, 1999). The systems give management and executives a unique and comprehensive look into the business and its processes.

The benefits of ERP systems are immense and in some instances necessary for competitive survival in today's global business climate. Benefits including heightened competitiveness, better communication, higher accuracy of information, and more timely information are all positive attributes gained by organizations with successfully implemented ERP systems (Umble et al., 2003). These attributes lead to

better decision-making, better vendor and customer relationships, and stronger customer loyalty. Along with the potential for huge benefits comes an equal price tag accompanied with well-documented failures driving some large organizations into bankruptcy. Many executives believe ERP implementation provides at least a moderate chance of damaging their organization because of possible problems encountered during the implementation of this vast system (Honig, 1999).

While the ERP methodology is an attractive and desirable tool for most twenty-first century corporations, successful implementation of ERP is difficult, challenging, expensive, and as a result frequently detrimental to organizations. Implementation requires leadership, change in technology, organizational change, and proper administration of knowledge management (Holsapple & Joshi, 2003). Organizations that have implemented ERP have followed various approaches for successful implementation; some as a result of research and others at the recommendation of vendors. Many attempt to implement ERP as they would any other type of change in information technology. Others follow a more intensive time consuming approach in pursuit of best business practices. Numerous other approaches are documented (Honig, 1999).

Considering the substantial dollar expenditure required and low success rate experienced in ERP implementations, it is critical for researchers to study and discover the benefit realized in ERP adoption, as well as posit the significant predictors' effects on ERP implementation practices (Brown & Vessey, 2003). Many organizations attempt to implement ERP as a change in technology while ignoring other critical attributes required at various levels of the organization that opportunely exist during such an implementation.

The attraction of adopting ERP systems to twenty first century competitors, coupled with the high cost and frequent failure experienced with ERP implementations leads to the need for further research on focal attributes for success in ERP implementation. While other studies have focused on the importance of business practices and people related issues, a study of the attention to the priority of adoption of new technology and the related impact on success is in order. As such, the purpose of this paper is to determine whether a focus on change in technology is necessary for successful implementation of ERP.

This question forms the basis for this study, and is thus fundamental to the following research. Since there is a gap in the literature associated with the connection of successful ERP implementation and a focus on the deployment of technology, the authors will focus on closing the knowledge deficit in this research paper.

The remainder of this paper is in four sections. The first section is the Literature Review composed of literature relevant to ERP implementation as a technology challenge versus other business problems, critical areas of ERP implementation, and critical success factors relating to people, business, and technology. Section two covers the research methodology and design of the research employed in this study. This section includes a description of the methodology, sample and population information, instrumentation, data collection and analysis procedures employed, researcher's philosophy, and theoretical framework guiding the research. Section three discusses the analysis of data and findings. . Section four concludes the research with a discussion of the findings, conclusions gained from the study, recommendations for further research, and assumptions / limitations of the study.

LITERATURE REVIEW

"ERP Systems represent the implementation of the old managerial dream of unifying and centralizing all the information systems required by the firm in one single system…" (Rowe, 1999). This single database system potentially places all elements of the organization in a position to work from one source of interrelated data – not multiple departments driven by islands of information.

When used appropriately, ERP provides a more effective and efficient environment that works from one database of information instead of relying on islands of information originated previously from each independent area of the organization. Successful ERP systems can be the backbone of business intelligence for an organization giving management a unified view of its processes better enabling control over those processes. While a response to the Y2K problems of many organizations, ERP systems were

known in the late 1990's and early 2000's for their extreme cost, high level of failure, and impractical justification to management (Gale, 2002). Contemporary strategies consider ERP necessary to improve organization productivity and efficiency in addition to being the base of business management and strategic positioning (Beheshti & Beheshti, 2010).

ERP Implementation – Technology Challenge versus Business Problems

As documented evidence illustrates, many ERP implementations result in failure. This failure often times is caused by the faulty approach the organization takes in planning the implementation process. While many anticipate the technical challenges to be the focal point of implementation efforts, they are often times not the main reason enterprise systems fail. ERP implementations, which focus exclusively on information technology, and not on the overall implementation of a system, are structured for failure. (Hsiuju & Chwen, 2004). Since the late 1990's, huge companies including Whirlpool, Hershey's Foods, Waste Management Incorporated, and W. L. Gore and Associates have encountered vast problems with their efforts to implement ERP. Several of these companies experienced problems that nearly bankrupt the company (Wah, 2000). Throughout the 2000's, the failure rate for ERP implementation continues to be high. The companies that have the kind of problems that lead to disaster are those that install ERP without thinking through its full business implications (Davenport, 1998).

Most companies find maximum benefits from treating technology first and foremost from a strategic and executive decision and point of view. They focus was on the effects and changes in the enterprise and not on the technology. Rather than just a technology implementation project, the major issues with ERP implementation are frequently business problems. Companies fail to reconcile the technological imperatives of the enterprise system with the business needs of the enterprise itself (Davenport, 1998). As such, the implementing managers must fully understand the critical areas that are affected by the installation of the ERP system.

Critical Success Factors (CSF's) of ERP Implementations

ERP implementation has some major issues and challenges. They can be summarized into three areas: 1) people, 2) technology, and 3) business (Nah et al. (2003), Somers and Nelson 2004, Laughlin 1999, and Krammeeraard et al. 2003). CSFs often have common characteristics, which can overlap, from one area into another. People and business related CSFs outnumber technological factors. Studies of ERP implementation failure support this emphasis on people and business related CSFs. In a survey of information technology managers, Information Week found that the top three reasons ERP projects failed was attributed to poor management (people / business), change in business goals (business), and lack of business management support (people / business) (Umble et al., 2003). Thus, ERP implementations often fail not because of the technology, but because of business and people issues (Somers & Nelson, 2004). Further, a study conducted among Fortune 1000 chief financial officers, found that CFO's ranked the five top CSFs of ERP implementations to be top management support (people), project champion (people), ERP teamwork and composition (people / business), project management (business / technology), and change management (people) (Nah et al., 2003). In addition, Rolls-Royce found in their ERP implementation found cultural (people), business, and technical difficulty as the primary areas of concern during their successful ERP implementation (Yusuf et al., 2004). Accordingly, CSFs should be grouped and viewed within these areas.

Other Critical Factors Success Approaches – Logical Associations

One approach to successful implementation of ERP follows the strategic alignment model of Henderson and Venkatraman (1999), which suggests that the success depends on different effective patterns of logical links, or "fits", among the "domains" of a firm. These domains are identified as business strategies, information technology strategy, organization infrastructure and processes, and information technology infrastructure and processes (Henderson & Venkatraman, 1999). Three factors for ERP success can be derived from these "fits". The first critical factor is the fit between business strategy and information technology strategy. The second fit is between the level of maturity of the information

technology infrastructure and the strategic role of information technology in relation to ERP. The third fit the fit between the methods used for implementing ERP and the change in organizational processes (Voordijk et al., 2003). Henderson and Venkatraman's (1999) approach further supports the segregation of CSFs into the areas of people, business, and technology related areas.

People, Business, and Technology Related ERP Critical Success Factors

To understand what factors are critical for success in ERP implementations, we reviewed works for four leading authors on the topic. Table 1 summarizes ERP implementation critical success factors (CSFs) emphasizing factors that affect people, business, and technology issues.

TABLE 1
CRITICAL SUCCESS FACTORS OF ERP IMPLEMENTATIONS BY SCHOLAR

Group	Critical Success Factor	Scholar			
		Nah et al. (2003)	Somers & Nelson (2004)	Laughlin (1999)	Kraemmeraard et al. (2003)
Technology	Appropriate Business & IT Legacy System	X			
Business	Business Plan & Vision	X	X	X	X
Business	Business Process Reengineering	X	X		X
People	Change And Expectation Management	X	X	X	
People	Communication	X	X	X	
People	ERP Teamwork & Composition	X	X	X	X
Business	Monitoring & Evaluation of Performance	X			
People	Project Champion	X	X		
Business	Project Management	X	X	X	
Technology	Software Development, Testing, & Troubleshooting	X			
People	Top Management Support & Involvement	X	X	X	X
People	Steering Committee		X		
People	Implementation Consultants		X		
People	Vendor-Customer Partnership, Tools, and Support		X		
People	User Training and Education		X		X
Business	Appropriate Software Selection		X		
Business	Minimize Customization		X		
Technology	Data Analysis and Conversion		X		
Technology	Defining the System Architecture		X		
Business	Dedicating Resources		X		
Business	Aggressive Schedule and Timelines			X	
Business	Focused Issue Resolution			X	
Business	Limited Scope			X	
Business	Early Success			X	
Business	Justification				X

Critical success factors that are affected by technology can be identified as: 1) appropriate business and information technology legacy systems, 2) software development, testing, and troubleshooting, 3) appropriate software selection, 4) data analysis and conversion, and 5) defining system architecture. The greater the complexity of legacy systems, the greater the amount of technological and organizational change required. To be successful, ERP implementation efforts must overcome issues of complexity arising from business and information technology legacy systems. A stable and successful business setting is essential, and success in other business areas is necessary for ERP implementation success (Roberts & Barrar, 1992).

In addition to appropriate business and legacy systems, software development, testing, and troubleshooting issues are CSFs for ERP implementations. Because of the high degree of integration of systems across the organization, development and testing perspectives unique to ERP projects must be well thought-out and managed. The overall ERP architecture should be established before deployment considering the most important requirements of the implementation (Murray & Coffin, 2001). Consequently, the use of appropriate modeling methods will aid in achieving ERP success. Requirement definitions should be created for documenting how the systems operate. Having a written sign off of requirement definitions protects all parties from downstream attack for non-documented "creeps" of scope and oversights within the creation of requirements definitions (Holland et al., 1999). While troubleshooting errors is critical, rigorous software testing eases implementation (Rosario, 2000).

Additional technological CSFs include data analysis and conversion and defining the system architecture. Accurate data is a fundamental requirement for the effectiveness of any system. The management of data converted and entered into the ERP system is a critical issue. Defining system architecture is a critical success factor as this provides the basis for running ERP software. Architecture choices and planning are especially during the design and procurement phase as system requirements of ERP systems may predicate specific needs (Somers & Nelson, 2004).

While the literature suggests focus on technology is often the source of failure, one would expect a focus on change in technology is necessary for successful implementation of ERP. Nevertheless, both the literature and scholars continually point out the large risk of potential failure in ERP due to the complexity of both technology change as well as change in business practices and culture in the organization. These facts would suggest a focus on change in technology would not be as necessary (or perhaps not necessary at all) for successful implementation of ERP. With these conflicting theories prevailing, the need for a study of importance of focus on technology on successful ERP implementations is in order if further substantiated.

RESEARCH METHODOLOGY AND DESIGN

Nature of the Study and Data Collection

This research is conducted using a quantitative methodology approach. The selection of instrument and collection of data supported the researchers with analyzing the achievement of success gained by adoption of ERP systems as correlated to the presence of focus in ERP implementation on change in technology. Participants in this study originated from North and South American organizations that completed their implementation of ERP in their organization more than one year prior to the date of the survey. The ERP systems implemented were developed and marketed by SAP, the world's leading provider of ERP systems holding a 24% market share; some 6 points higher than the nearest single competitor Oracle (Panorama Consulting, 2011).

To analyze the research question (“Is a focus on the change in technology required by an ERP adoption observed in successful ERP implementations?”), the authors collected empirical data about this topic. Survey questions about organizations’ reliance on technology and technology related actions were developed and the responses were assessed for success in the ERP implementation process. The questions were derived from the critical success factors relating to technology, as well as other items referred to in the literature review relating to technology.

The survey population consisted of over 3500 SAP users who are members of the Americas' SAP User's Group (ASUG). A sample of 600 random SAP user organizations having completed implementation of ERP more than one year after initial implementation and no more than 5 years subsequent to implementation represent the sample studied in this research. The survey of these 600 SAP user organizations resulted in a total of 239 responses, or 39.8% response rate (see Table 2). Sixty-six of these responses were not used because their implementations had occurred within the past year and fell outside the scope of the study. An additional forty-seven responses were not used due to incomplete survey responses. The final number of valid responses that were used totaled 126 representing a response rate of 21%. This response rate is within the acceptable level for e-mail surveys of this type (Prahalad & Hamel, 1990). Table 2 illustrates the distribution of the respondents to the questionnaire.

TABLE 2
SURVEY RESPONSE RATE

	N/n	% sample	% valid
Total Sample Size	600	100.0%	n/a
Total Responses	239	39.8%	n/a
Incomplete Responses	47	7.8%	n/a
Valid Responses to Survey*	126	21.0%	100.0%
Met At Least One Success Factor	64	10.7%	50.8%
Met No Success Factors	62	10.3%	49.2%
Met ROI Objective	41	6.8%	32.5%
Met All Objectives**	18	3.0%	14.3%

*Responses in which ERP was implemented more than 1 year prior to survey

**Met ROI and All Success Objectives

The survey instrument was made available via the Internet, to the sample under study via surveymonkey.com - an independent online survey organization. A random selection of SAP implementations, which had occurred in the past 3 years from the date of survey, formed the base of the sample for this study. All participants were notified prior to the survey and two follow-up notifications were also sent to encourage participation in the survey. The initial contact was made approximately one week prior to first contact instructing the user group sample on how to take the survey.

Analysis

Our analysis was based on the data received from the surveys. Each observation in the survey contained a response to attribute questions, as well as a coded indication of whether the respondent indicated his/her organization's implementation was a success (one or more success variables present) or not a success (no success in which no success variables were present), as determined from prior analysis described earlier. The data from these attribute responses was examined and summarized. Our analysis focused on the following tests: the frequency of attributes for success versus no success implementations, correlation of attributes to success and no success, and significance of difference for each attribute as it relates to success versus no success observations.

The first step in the analysis was to determine the tests most suitable for use; the data was first tested to evaluate the normality assumption. A visual observation of data graphed in a histogram, and the Kolmogorov-Smirnov test was conducted to evaluate the normality assumption. Based on these two tests, the normality assumption failed for all attributes in all categories. As a result, three non-parametric tests were selected; – the Spearman Rank Correlation for correlation testing purposes, the Kruskal-Wallis test, and the Mann Whitley test for test of significant differences.

RESULTS AND FINDINGS

The first section of this analysis describes the demographic information from the respondents based on their responses to the survey. Characteristics include the location of where the respondent company is based, annual sales of the company, and responsibility of the respondent, industry in which the company participates, implementation status of ERP in the company, and ERP modules implemented. This section also addresses how respondents were segregated into successful versus unsuccessful categories.

Over 88% of the respondent organizations were based in the United States with the remaining 10% evenly distributed over Mexico, Canada, and outside North America. Successful versus non-successful organizations were nearly identical to these percentages with neither section significantly over or under the total response splits.

The majority of the respondents were manufacturing companies (38.9% of the total) while government, food and beverage, and computer software and services ranked second, third, and fourth with 12.7%, 8.7% and 7.1% of the sample total, respectively. The percentages of success versus no success categories showed similar representation to the total sample, however, 13% fewer organizations were from the manufacturing area, and 10% more were from the government in the no success category versus the success category.

The largest number of organizations represented in the survey (31%) had annual sales between $1 and $5 billion dollars. The second (27%) and third (17.5%) largest categories of annual sales representing surveyed organizations reported sales of over $5 billion and $500 million to $1 Billion, respectively. The responses for success and no success categories were similar in rank and percent to the total response statistics with no significant deviation.

The majority of the survey respondents are from the information technology discipline (79%). The majority of respondents appear to be in higher-level positions with no significant difference in the number of respondents in success versus no success responses.

As mentioned earlier, organizations that indicated their implementation had taken place less than one year from the time of the survey were removed from valid responses in the sample. The reason for their removal is due to the fact that organizations need at least one year of ERP operation results in order to reasonably determine if ROI and success objectives have been met.

Over 48% of the respondent organizations reported implementing ERP more than 5 years prior to the survey, while 25.4% implemented ERP within 1 to 2 years prior to the survey. A significant difference was observed in the success versus no success categories with more than twice as many no success 1 to 2 years implementation were reported for no success (22 or 35.5%) than were in the success 1 to 2 years implementation category (10 or 15.6%). In addition, more than twice as many in the success category that implemented over 5 years prior were observed (41 or 64.1%) than in the no success category (20 or 32.3%).

The highest frequency of implementation teams was over 20 members large which also held true for success (73.4%) versus no success (79%) categories. Implementation teams with 10 to 20 members were the second highest frequency for both success (20.3%) and no success (14.5%) categories.

Top Management was responsible for the decision to employ ERP in 54% of the sample followed Business Process Leaders / Business Unit Managers with 23% of the sample. The results of the success and no success categories were very similar to the overall sample results.

A total of 27.8% (35) of the total 126 responses considered valid for the study did not consider any other ERP vendor for their implementation (25% or 16 of the success responses, 30.6% or 19 of the no success responses). Over 40% of all respondents looked at Oracle (SAP's top competition) and 33% looked at PeopleSoft (now a part of Oracle). In further analysis of the success versus no success category, the success respondent organizations looked at more ERP options 23.6% more of the time than the no success category.

Success versus No Success

The second step in the analysis focused on measuring the successful ERP implementations against unsuccessful. As previously noted in Table 2, of the 239 total responses, 126 responses were usable for this research purpose. The 126 valid responses were examined for ERP operations, whether they were successful or not. This success/no success determination was based on nine measurement criteria. Respondents indicating the presence of one of more of these factors were considered to have achieved success in adoption of their ERP system. The nine criteria measured as a part of the survey are:

1. Realized expected Return on investment
2. Realized ROI > 5%
3. Increased productivity => 2%
4. Reduced operational cost by 5%
5. Experienced reduction in scheduling and planning cycle > 50%
6. Experienced reduction in delivery times => 10%
7. Realized reduction in production time => 10%
8. Reduced inventory stock =>10%
9. Reduced late deliveries => 25%

These nine criteria were derived from the quantitative success factors cited in the "Attributes For Success" section of Chapter 2 Literature Review.

As shown in Table 2 previously, 64 of the 173 valid responses met at least one or more of the ERP surveyed success factors, leaving the remaining 62 of which responses indicated that no success factor was achieved.

TABLE 3
FREQUENCY OF CHANGE IN TECHNOLOGY FOCUS ATTRIBUTES

Frequency of Non-Successful Implementations Focusing on a Change in Technology

	Yes		Somewhat		No	
	n	*%*	*n*	*%*	*n*	*%*
Skilled Consultants	24	38.7%	32	51.6%	6	9.7%
ERP Vendor Involved	23	37.1%	26	41.9%	13	21.0%
ERP Software modified to meet needs	17	27.4%	30	48.4%	15	24.2%
Appropriate business and IT legacy systems used	26	41.9%	29	46.8%	7	11.3%
Project champion was knowledgeable about ERP and implementation	22	35.5%	25	40.3%	15	24.2%
ERP software was tested and "troubleshooted"	28	45.2%	29	46.8%	5	8.1%
ERP software selection was appropriate for business	39	62.9%	20	32.3%	3	4.8%
Historical data was analyzed and converted efficiently and logically	26	41.9%	24	38.7%	12	19.4%
System architecture well defined prior to implementation	26	41.9%	24	38.7%	12	19.4%
Technology was prepared to implement	36	58.1%	21	33.9%	5	8.1%

Frequency of Successful Implementations Focusing on Change in Technology

	Yes		Somewhat		No	
	n	%	*n*	%	*n*	%
Skilled Consultants	34	53.1%	26	40.6%	4	6.3%
ERP Vendor Involved	36	56.3%	19	29.7%	9	14.1%
ERP Software modified to meet needs	17	26.6%	27	42.2%	20	31.3%
Appropriate business and IT legacy systems used	45	70.3%	18	28.1%	1	1.6%
Project champion was knowledgeable about ERP and implementation	36	56.3%	20	31.3%	8	12.5%
ERP software was tested and "troubleshooted"	52	81.3%	12	18.8%	0	0.0%
ERP software selection was appropriate for business	53	82.8%	11	17.2%	0	0.0%
Historical data was analyzed and converted efficiently and logically	32	50.0%	24	37.5%	8	12.5%
System architecture well defined prior to implementation	42	65.6%	18	28.1%	4	6.3%
Technology was prepared to implement	45	70.3%	18	28.1%	1	1.6%

Tables 3 and 4 show the frequency of focus on technology attributes for success versus no success implementations. Nine of ten attributes revealed higher frequency in observations where success was observed as opposed to observations where success was not observed. The only observation which showed a higher frequency in no success observation, was "ERP software modified to meet needs." This attribute showed a .8% higher frequency for no success implementations versus success implementations. All other attributes show a significantly higher frequency in the success ERP implementations of at least 8% higher with some attributes being as much as 40% higher.

As previously stated, an alternate non-parametric test – the Spearman Rank Correlation, was used to analyze the change in technology focus attributes for correlation by attribute to success in ERP implementation. The Spearman Rank Correlation is an analysis tool used to show whether a correlation between two variables exists. If a correlation exists, the Sig. (2-tailed) *p* test value is less than .05. Another feature of the Spearman Correlation Rank analysis tool is the correlation coefficient. If the *p*-test value is less than .05 indicating a correlation exists, the correlation coefficient shows the strength of the correlation. The closer the correlation coefficient is to 1, the greater the correlation strength. Table 4 shows the results of the Spearman Rank Correlation.

The Spearman Correlation shows 3 of the 10 focus attributes indicate a correlation exist between the attribute and a successful ERP implementation. These three focus attributes are, 1) Appropriate business and IT legacy systems used, 2) ERP software was tested and "troubleshooted," and 3) ERP software selection was appropriate for business. However, further examination of the data indicates that each of the focus attributes showing a correlation shows a weak strength of correlation. This is observed in the correlation coefficient for each variable. For each of the three correlated variables, the closer the correlation coefficient is to 1, the correlation coefficient, the stronger the strength of the correlation. The correlation coefficient in two attributes is below .2 and under .4 in the third indicating a weak correlation in all three attributes.

TABLE 4
SPEARMAN'S CORRELATION RANK FOR FOCUS ON CHANGE IN TECHNOLOGY

	Spearman's Correlation Coefficient	Sig. (2-tailed)
Skilled Consultants	0.146	0.103
ERP vendor involved	0.120	0.181
ERP software modified to meet needs	0.054	0.550
Appropriate business and IT legacy systems used	0.210	0.019
Project champion was knowledgeable about ERP and Implementation	0.133	0.138
ERP software was tested and "troubleshooted"	0.378	0.000
ERP software selection was appropriate for business	0.229	0.010
Customization of software was minimized	0.005	0.953
Historical data was analyzed and converted efficiently and logically	0.077	0.394
System architecture well defined prior to implementation	0.142	0.115
Aggressive schedule and timeline used for implementation	0.169	0.060
Technologically prepared to implement?	0.131	0.146
ERP necessitated requirement of new skill set for computer proficiency?	0.071	0.432

Sig. (2-tailed) p test < .05 indicates a significant correlation

Considering the frequency of attributes present in successful ERP implementations and the results of the Spearman Correlation Rank were conflicting, the Mann Whitley test was conducted and considered appropriate to determine if a significant difference in the distribution of observations indicated success in ERP as correlated to the focus attributes. The Mann-Whitney test examines the difference in the distributions of success and no success observations. The results of the Mann Whitney test are shown in Table 5. The Mann Whitley tests for significance shows 3 of the 10 attributes have Asymp. Sig. (2-tailed) values less than .05, which indicate a significant difference in the distribution of change in technology attributes for success versus no success observations. The three attributes are: 1) Appropriate business and IT legacy systems used, 2) ERP software was tested and "troubleshooted," and 3) ERP software selection was appropriate for business. These three attributes are the same attributes that the Spearman Correlation Rank indicated a correlation existed.

Further examination of the Mann Whitley test indicates that these three attributes show a direction towards non successful implementations. This exists because the higher mean rank for each attribute of no success versus lower mean rank for success.

TABLE 5
MANN WHITLEY TEST FOR SIGNIFICANCE IN TECHNOLOGY CHANGE ATTRIBUTES

			Mean Rank	
	Mean	Sig. Test	No Success	Success
Skilled Consultants	1.62	0.103	68.34	58.81
ERP vendor involved	1.66	0.180	67.03	59.03
ERP software modified to meet needs	2.01	0.548	61.65	65.29
Appropriate business and IT legacy systems used	1.40	0.019	69.86	56.46
Project champion was knowledgeable about ERP and Implementation	1.62	0.137	67.57	58.64
ERP software was tested and "troubleshooted"	1.39	0.00	74.70	51.84
ERP software selection was appropriate for business	1.27	0.011	69.54	56.77
Customization of software was minimized	1.68	0.953	63.18	59.81
Historical data was analyzed and converted efficiently and logically	1.64	0.391	65.63	60.49
System architecture well defined prior to implementation	1.49	0.114	67.62	58.59
Aggressive schedule and timeline used for implementation	1.30	0.060	58.25	59.81
Technologically prepared to implement	1.39	0.146	67.03	59.16
ERP necessitated new skill set for computer proficiency	1.29	0.429	64.43	60.63

Sig. (2-tailed) p test < .05 indicates a significant correlation

Based on the results of the Spearman Correlation Rank, and the Mann Whitney test for change in technology focus attributes, there is insufficient evidence to conclude a focus in technology attributes is necessary for successful ERP implementations.

DISCUSSION

So What Does the Data Tell Us?

A review of the descriptive statistics indicates a higher frequency in observations where success was observed (90%) as compared to those observations in which success was not observed (10%) in ERP implementations. The only attribute that exhibited a higher frequency for unsuccessful ERP implementations was "ERP software modified to meet needs," This sole reason for this could stem from two main reasons. One explanation could be that the successful company's employs best practices attributes more often. This approach favors little customization of ERP software. Another explanation

could be SAP's continuing efforts to make their ERP systems as flexible as possible, by requiring little customization of the existing software.

The Spearman Rank Correlation indicated a 30% focus toward successful ERP implementations versus 70% unsuccessful. These three attributes include, 1) appropriate business and IT legacy systems used, 2) ERP software was tested and "troubleshooted," and 3) ERP software selection was appropriate for business. Further analysis of the Spearman Rank results revealed a weak correlation for all three of these elements to successful ERP implementations. In addition, the Mann Whitley tests for significance showed 3 of the 10 attributes have Asymp. Sig. (2-tailed) values less than .05, which indicate a significant difference in the distribution of change in technology attributes for success versus no success observations. The three attributes are: 1) Appropriate business and IT legacy systems used, 2) ERP software was tested and "troubleshooted," and 3) ERP software selection were appropriate for business. These three attributes are the same attributes that the Spearman Correlation Rank indicated a correlation existed. Further study of the Mann Whitley test indicates these three attributes show direction to no success implementations as witnessed through the higher mean rank for each attribute for no success versus lower mean rank for success. Neither the Mann Whitney nor the Spearman Correlation Rank results supported the findings of the analysis of frequency.

Due to the conflicting results, it can be concluded that a lack of evidence exists to show any correlation of focus on technology attributes to successful ERP implementations. This conclusion is supported by the 70% lack of correlated attributes, the weakness in the attributes (30% of the total) to successful ERP implementations in the Spearman Correlation Rank, and the inconsistency of significant differences of attributes supporting non-successful ERP implementations.

CONCLUSIONS

The purpose of this study was to understand the relationship of successful ERP implementation and the adoption of new technology during implementation process. Based on the findings of this research, we can say that, overall, when SAP ERP systems are implemented, 50.8% of implementations show successful results. This success is measured in terms of achieving at least one success attribute such as

- realizing target return on investment, or
- realizing return on investment greater than 5%,
- increasing productivity by at least 2%,
- reducing operational cost by at least 5%,
- reduce scheduling and planning of more than 50%,
- reduction in delivery time by at least 10%,
- reduction in production time by at least 10%, r
- education in inventory by at least 10%,
- reduction in late deliveries by at least 25%.

This research also shows that ERP implementations using SAP meet their return on investment objectives 32.5% of the time, and reach all previously mentioned success attributes 14.3% of the time.

We can also conclude that our study of the SAP ERP implementations we surveyed show little to no correlation to a focus on change in technology. While the descriptive statistics for attributes showed that successful ERP implementations employed 9 of 10 technology attributes more often than in no success implementations, further testing for correlation proved inconclusive results that a correlation existed. Considering the fact that ERP is an intensive information system based initiative as noted in the review of literature, this finding is surprising. However, considering the fact that while all implementations have diverse demographic factors (i.e. different modules implemented, different business / industry in which implementations took place, etc.) which may have more diverse or different change management and best business practices, SAP may have perfected the technological side of ERP implementations to the degree

that firms do not have to be as concerned with changes in technology as they do with focusing on change management and best business practices.

MANAGERIAL IMPLICATIONS

The intent of this research was to identify whether a correlation exists between successful implementation of ERP and the presence and / or absence of focus on a change in technology. Based on the conclusions and findings, the researchers suggest the following recommendations to organizations implementing SAP ERP:

1) It is recommended that organizations considering ERP system implementations consider the success versus no success rate of success as gained from employing ERP before they commit to the ERP initiative. It is recommended that they consider the demonstrated rate of success strongly as the commitment, attention, discipline, and change required for successful implementations is significant.

2) It is recommended that all organizations implementing ERP consider all critical success factors, success attributes, and groups of success attributes when planning for ERP implementations.

3) It is recommended that all organizations implementing ERP consider prioritizing their focus on the effects and changes in the enterprise as a result of implementing ERP and not on the technology used in implementation. Appropriate emphasis should be placed on ERP technological concerns (i.e. selecting the proper ERP system, mapping old and new systems, migration of data, etc.); however, the business needs of the enterprise itself should take higher priority.

4) It is recommended that technology be treated from a strategic and executive decision and point of view with more emphasis placed on business problems in ERP implementations.

5) It is recommended that top management be informed of the commitment to an ERP implementation (including the amount of resources necessary for successful ERP implementations, the critical success factors necessary for ERP implementations, and the demonstrated results of failures (i.e. running over budget) in order to prepare and make contingency plans for the possible impact of ERP implementations.

6) It is recommended that organizations educate users, management, suppliers, and customers that while ERP does incorporate an adoption of new technology and focuses to some degree on an information system based approach, a focus on business challenges and problems existing from adoption of ERP rather than the change in technology are more important.

ASSUMPTIONS AND LIMITATIONS, AND FUTURE RESEARCH OF STUDY

The following assumptions and limitations apply to this research:

1) The areas represented in the survey instrument were extracted from critical success factors and grouped into three categories: technology (of which change in technology is focused), people (i.e. users or employees, of which change management is focused), and business practice (of which change from a currently employed practice to a new best business practice is focused).

2) An assumption was made that a successful ERP implementation can be determined by identifying minimum goals of an ERP system, which are identified in the literature review.

3) The respondents honestly answered the survey and had no reason to do otherwise.

4) Data to corroborate the existence of a correlation between ERP success and successful ERP implementation attribute groups can be gathered through the survey instrument.

5) Respondents of the survey had responsibility, as well as the appropriate proficiency for making decisions regarding ERP implementation, for their respective companies implementing ERP.

6) The survey instrument was structured for the purpose of finding comprehensive factual unbiased information was appropriate for the assessment of such information, and the statistical

procedures applied were appropriate to measure the significance of a measured correlation between success and the existence of the focus areas previously mentioned.

7) The survey instrument was dependent upon self-reported data as well as subjective opinions.

While this study provides comprehensive research to the presence of significant focus for successful ERP implementations, it raises additional questions for further research. Recommendations for further research include the following:

1) Conduct a study of Oracle and other ERP implementations to compare to the SAP results. Test for similar findings noting the similarities and differences between different ERP vendor offerings as correlated to successful ERP implementations.

2) Conduct a study to further understand and validate why a focus in change in technology showed no significance. Such a study might include a comparison of various ERP vendors to test for differences in the focus on technology attribute for organizations favoring particular vendors from a technology standpoint.

3) Conduct a study to validate and further understand the success measures specific to organizations measuring ERP success.

4) Conduct a study of correlation of individual ERP modules and the combination of ERP modules to ERP success measures for further analysis of technological reliance and correlated success.

REFERENCES

Adam, F., & O'Doherty, P. (2000). Lessons from enterprise resource planning implementations in Ireland - towards smaller and shorter ERP projects. *Journal of Information Technology, 15*(4), 305 - 316.

Beheshti, H. M., & Beheshti, C. M. (2010). Improving productivity and firm performance with enterprise resource planning. *Enterprise Information Systems*, *4*(4), 445-472.

Brown. C., & Vessey. I. (2003), Managing the next wave of enterprise systems: leveraging lessons from ERP. MIS Quarterly Executive, 2 (1), 45–57.

Davenport, T. H. (1998). Putting the enterprise into the enterprise system. *Harvard Business Review, 76*(4), 121 - 131.

Davis, M. M., & Heineke, J. (2005). *Operations management - integrating manufacturing and services* (5th ed.). New York: McGraw-Hill Irwin.

Gale, S. (2002). For ERP success, create a culture change. *Workforce, 81*, 88-91.

Henderson, J. C., & Venkatraman, N. (1999). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal* (2), 472 - 484.

Hislop, D., Newel, S., Scarborough, H., & Swan, J. (2000). Networks, knowledge and power: Decision making, politics and the process of innovation. *Technology Analysis & Strategic Management, 12*, 399-412.

Holland, C. P., Light, B., & Gibson, N. (1999). A critical success factors model for enterprise resource planning implementation. *Proceedings of the 7th European Conference on Information Systems, 1*, 273 - 297.

Honig, S. (1999). The changing landscape of computerized accounting systems. *The CPA Journal, 69(5)*, 14 - 19.

Holsapple. C.W., Joshi. K.D. (2003). A knowledge management ontology. *Handbook on Knowledge Management: Knowledge Matters,* Springer-Verlag, New York, 89–124.

Hsiuju, R. Y., & Chwen, S. (2004). Aligning ERP implementation with competitive priorities of manufacturing firms: An exploratory study. *International Journal of Production Economics, 92*(3), 207 - 220.

Kuhn, T. (1962). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.

Murray, M., & Coffin, G. (2001). A case study analysis of factors for success in ERP system implementations. *Proceedings of the 7th Americas Conference on Information Systems*, 1012 - 1018.

Oliver, D., & Romm, C. (2002). Justifying enterprise resource planning adoption. *Journal of Information Technology, 17*(4), 199 - 214.

Panorama Consulting Group (2011). *2011 ERP Vendor Analysis*, Copyright 2011 Panorama Consulting Group, 2.

Porter, M. E. (2001). Strategy and the Internet. *Harvard Business Review, 79*(3), 62 - 78.

Prahalad, C., and Hamel, D. (1990). The core competence of the corporation. *Harvard Business Review, 68*(3), 79–91.

Ragowsky, A., & Somers, T. M. (2002). Special section: Enterprise resource planning. *Journal of Management Information Systems, 19*(1), 11 - 15.

Roberts, H. J., & Barrar, P. R. N. (1992). MRPii implementation: Key factors for success. *Computer Integrated Manufacturing Systems, 5*(1), 31 - 38.

Rosario, J. G. (2000). On the leading edge: Critical success factors in ERP implementation projects. *Business World*, 27.

Rowe, F. (1999). Coherence, integration informationnelle et chagement: Esquisse d'un programme de recherché a partir des progiciels integres de gestion. *Systemes d'Information et Management, 4*, 3-20.

Scalle, C. X., & Cotteleer, M. J. (1999). *Enterprise resource planning (ERP)*. Boston: Harvard Business School Publishing.

Somers, T. M. t., & Nelson, K. G. (2004). A taxonomy of players and activities across the ERP project life cycle. *Information & Management, 41*(3), 257- 278.

Umble, E. J., Haft, R. R., & Umble, M. M. m. (2003). Enterprise resource planning: Implementation procedures and critical success factors. *European Journal of Operational Research, 146*(2), 241 - 257.

Voordijk, H., Van Leuven, A., & Laan, A. (2003). Enterprise resource planning in a large construction firm: Implementation analysis. *Construction Management & Economics, 21*(5), 511 - 521.

Yusuf, Y., Gunasekaran, A., & Abthorpe, M. S. (2004). Enterprise information systems project implementation: A case study of ERP in Rolls Royce. *International Journal of Production Economics, 87*(3), 251 - 266.

Wah, L. (2000). Give ERP a Chance. *Management Review*, 89(3), 20 – 24.

APPENDIX A

The survey questions used to analyze the research question are as follows:

Please indicate the extent to which the statements below are true for your organization's implementation.
i. The project had skilled consultants.
k. The ERP vendor was involved in our project.
m. The ERP software was modified to meet our needs.
r. Appropriate business and IT legacy systems were used.
u. The project champion was knowledgeable about ERP and the implementation.
x. The ERP software selection was appropriate for our business needs.
z. Historical data was analyzed and converted in an efficient logical manner.
aa. System architecture was well defined prior to implementation.

Please answer the questions below regarding your implementation.
g. Was your organization technologically prepared to implement?
i. Has ERP implementation necessitated the requirement of a new skill set among employees in terms of computer proficiency?