A Roadmap for E-Business Implementation

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Abstract: The rapid deployment of e-business systems has surprised even the most futuristic management thinkers. Unfortunately, little empirical research has documented the variations of e-business solutions as major software vendors release complex IT products into the marketplace. The literature holds simultaneous evidence of major successes and major failures as implementations evolve. The current economic conditions have slowed implementation efforts but most companies report ongoing efforts to further strengthen their investment in e-business as they anticipate a reinvigorated marketplace. In this research, we first distinguish and develop a conceptual model of e-business and its predecessor concepts of e-commerce, supply chain management (SCM), and enterprise resource planning (ERP) and demonstrate how these systems relate and serve significantly different strategic objectives. This research combines interviews, case studies and an industry survey to determine the significant variables leading to successful implementation of e-business systems. Based on the research finding, we build cause-effect diagrams illustrating the significant relationships between the variables suggested in the literature and actual success scores for e-business systems. We use these findings to suggest an implementation roadmap using four stages for implementing e-business systems: planning, developing, implementing, and testing. The roadmap indicates when and where the significant success variables would appear and how a firm might manage the implementation process.

Keywords: E-Business, Enterprise Resource Planning (ERP), Supply Chain Management, E-Commerce

EMJ Focus Areas: Knowledge and Information Management

Considerable confusion exists in the literature concerning the various terminologies used to describe e-business. Terms abound with vague descriptions and loose connections to existing management literature and even more cryptic relationships to evolving technology. In this article we offer what we believe are the core components of e-business: enterprise resource planning (ERP), supply chain management (SCM), and e-commerce. In Exhibit 1 we show the relationship between these core processes. It is important to note that a business may not deploy every component or even attempt to link the three components. Some texts use the term "enterprise resource management" or ERM as a comprehensive term to include all e-business systems in one conceptual entity. We believe that these systems are distinctly different, serve specific functions, and may or may not "add up" to a comprehensive organizational capability.

The widespread adoption of e-business technology has major implications for the engineering manager responsible for the operation of systems and processes that rely on electronic data interchange and supply chains. The basic design of modern production systems and most all consumer products industries are significantly impacted by the relentless drive to control costs and quality. We believe that engineering managers need a solid understanding of these systems, because they will likely be involved in the design of these systems and they will be an integral part of the implementation of these industrial processes.

ERP is a system for integrating business processes found in manufacturing environments. It helps business processes be more flexible and responsive by breaking barriers between functional departments and by reducing duplication of effort. Most ERP systems are only used in internal process integration—finance and accounting, human resource, order management (sales), and manufacturing, and these typically have not had significant collaboration with outsourcing suppliers and customers; however, ERP is now moving to ERP II. ERP II is more focused on supply

About the Authors

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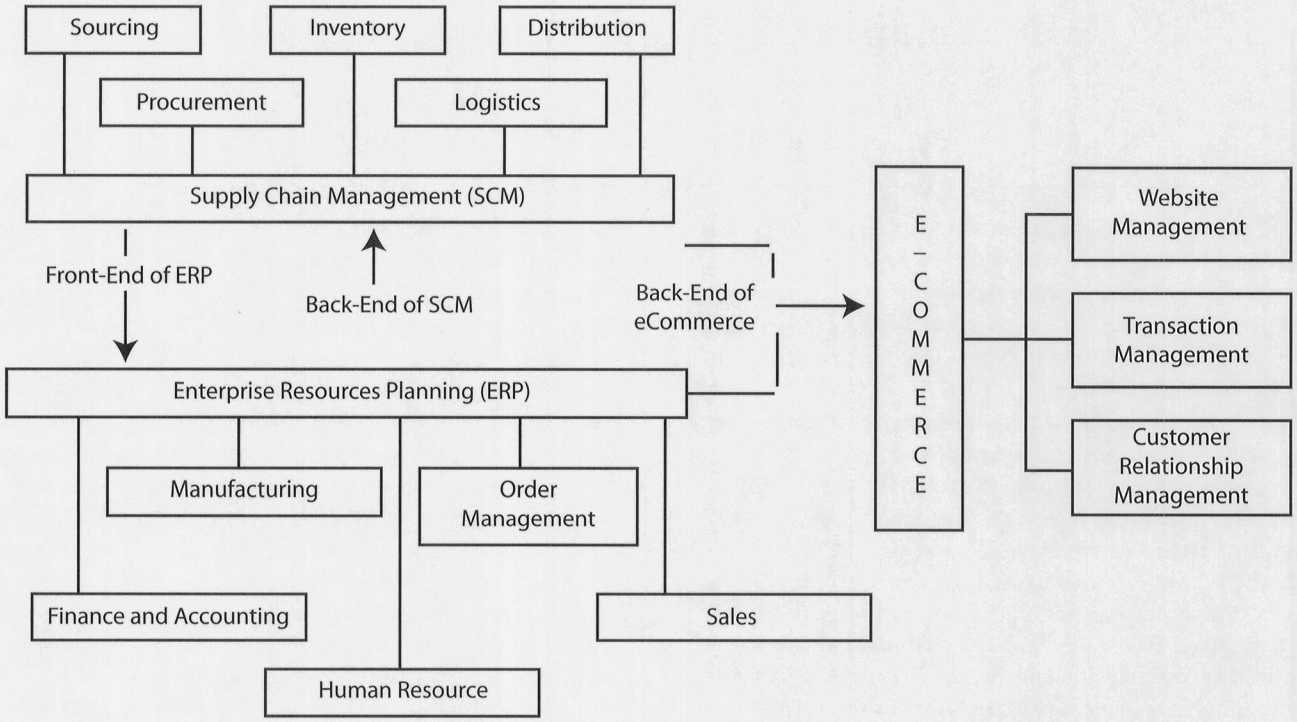
Exhibit 1. The Relationship Between ERP, SCM and eCommerce



chain management rather than internal business process. The ERP market is predicted by industry prognosticators to sustain an annual growth rate of 30% to 40%. The market could grow from a current $15 billion to $50 billion in the next five years (AMR, 2001).

SCM is a process of collaborating with outsourcing suppliers and customers for sharing, exchanging and moving information and goods. SCM consists of activities associated with the specification, flow and transformation of goods from the raw materials stage to the end users, as well as the associated information flows. Material and information flow both up and down the supply chain. SCM is the integration of these activities to achieve improved supply chain relationships to yield a sustainable competitive advantage through higher product quality and lower cost.

Because of new information technology such as the Internet, businesses market and sell their products and services on the Web in a trend called e-commerce. Businesses are also using these technologies to improve their ability to provide service to customers and to improve their operational performance to gain competitive advantage through customer self-service, quick response to customers, reduced product lead time, and reduced inventory levels. E-commerce is also quickly being adopted in internal functional areas such as procurement, R&D, and product design to leverage the knowledge and expertise of specialists within the organization.

When ERP, SCM, and e-commerce vendors are launching their new products, they all claim their products can help businesses achieve multiple goals and gain competitive advantage. Businesses know they have to implement e-business systems because of new technologies (Internet, etc.) or they will lose market share; however, when a vendor sells their products to businesses, they may not help them evaluate and adjust their environment to gain the promised benefits from their investment. It is not evident from the literature how a business should decide to implement an e-business system or how they should prepare themselves to make changes and adjustments to their current operations. We propose to use interviews, case studies and survey data to suggest a roadmap for e-business system implementation.

Case Studies and Interview Insights

In order to better understand the implementation of e-business systems, we interviewed three manufacturing company managers who had implemented e-business and ERP systems. We combined these interview assessments with Harvard Business School case studies that have been crafted to illustrate both successful and failed implementation examples of ERP system implementation (Escalle and Cotteleer, 1999; Westerman and Cotteleer, 1999; McAfee, 1997; Austin, Nolan, and Cotteleer, 1998; Stedman, 2000). Based on these interviews and analysis of cases, we crafted a survey instrument and used it to solicit quantitative assessments of the degree to which key implementation variables correspond with overall project success. We show first the insights gained from interviews and Harvard Business School case studies (Escalle and Cotteleer, 1999).

Insight from Interviews.

1. The reasons for implementing an ERP system included:
   - The companies grew very quickly and their legacy systems could not support them. Also, it was costly to re-code the legacy system and it was difficult to maintain the old system.
   - Due to the Y2K problem, implementing ERP systems was much easier and less expensive than recoding legacy systems.
   - The accomplishment of business process reengineering (BPR).

2. In each case, the ERP system did not meet all their expectations and the business process reengineering that was promised did not fully materialize.

Insights from the Harvard Business School Survey.

1. In general, the cases reveal that ERP technology could not support their businesses processes by itself.
2. Their business organizations found it was difficult to make changes needed to extract benefits from the new systems.
3. Some companies actually experienced damage to their businesses as a result of ERP implementation.
4. Overruns on cost and schedule targets were common.
5. Company managers expressed underachieved expectations and benefits.

Critical issues affecting an ERP implementation have been discussed in several articles and cases, such as business processes reengineering, ERP-legacy integration, implementation cost and schedule, top management commitment, effective and strong project management, and project members' qualifications (Escalle and Cotteleer, 1999; Westerman and Cotteleer, 1999; McAfee, 1997; Austin, Nolan and Cotteleer, 1998; Stedman, 2000). Some examples of successful and failed implementations of ERP also show that ERP could make businesses significantly more competitive, but, ERP could also cripple or kill a business (Escalle and Cotteleer, 1999; Westerman and Cotteleer, 1999; Austin, Nolan, and Cotteleer, 1998; Welti, 1999). Understanding the underlying physical supply chain management problem and the characteristics of their products for choosing the right supply chain software for their product line is also discussed in some articles (Fisher, 1997; Walker and Alber, 1999).

Success Key Criteria and Variables for E-Business

It is clear that the sources of information on e-business solutions differ regarding the descriptions of costs and benefits. Each vendor is carving out a niche where their technology strengths influence the type of software that they deploy and the way the system is integrated into the host organization (www.sap.com, www.i2.com, www.peoplesoft.com, www.oracle.com).

How then does a company determine what type of system they need; and, once this decision is made, how is a vendor selected and the implementation process managed? We suggest that the literature and case studies do support a set of key success criterion that might guide the answers to these questions. Also it appears that a relatively small collection of variables seems to significantly influence the degrees to which the success criteria are achieved and these variables tend to be the same regardless of the type of e-business system. In Exhibit 2 we summarize an interpretation of our literature research to suggest the key success criteria for each e-business component and the underlying common variables that influence successful implementation (Simchi-Levi, Kaminsky, and Simchi-Levi, 2000; Crisler, 2000; Tsai, 1997; Connolly, 2000; Levis, 2000).

Key Success Criteria. It is evident from the literature that the success criteria are quite different for each type of system. The reader has to be careful to distinguish what is promised for the business user versus what is promised in terms of technology. It is not a simple task to convert the software providers' advertising claims into strategic business objectives. We believe that some degree of accomplishment is necessary in each success criteria in order to claim a genuine system level success.

Key Independent Variables. Several variables appear to drive successful e-business implementations. A critical component is the support of the executive level management group. This group should be committed to the change process that implementing e-business systems is sure to cause. It appears that a combination of software vendor consultants and third party consultants are used by most implementers of e-business systems. The success of the system is likely influenced by the selection of the consulting team. Successful implementation tends to share the property that the initial budget and schedule predictions are feasible. Most implementations report significant cost and schedule overruns but the successful ones appear to be able to justify the errors and work around the resource issues. Finally, the implementation team composed of functional members and technology members seems to appear frequently in successful implementations. In Exhibit 3 we show the list

Exhibit 2. Success Criteria for E-Business Systems

ERP	SCP	E-Commerce
Business processes reengineering	Business processes reengineering	Customer satisfaction
Reduced inventory level	Reduced inventory level	Online product catalog
Reduced logistics cost	Reduced logistics cost	Tight integration between ERP and SCP systems
Reduced procurement costs	Reduced procurement costs	Secure electronic payment
Order fulfillment performance	Order fulfillment performance	Reduced costs (e.g., printing, postage)
Increased productivity and flexibility	Better response to partners in the supply chain	Online customer service
Standardization of computing platforms	Faster time to market	
Global sharing of information	Creation of new market opportunities	
Improved responsiveness to the customer	More reliable demand forecast	

of key variables that our research indicates are the drivers for implementation success.

Methodology

Using the key success criteria and key implementation drivers uncovered by case studies and interviews and documented in Exhibits 2 and 3, we constructed a survey instrument and hosted the survey on a web site where we could invite practitioners from industry to supply opinions. We partnered with The Association of Operations Management (APICS) to conduct the e-business survey. APICS provided a random 500 member contact list and we randomly selected 250 members to participate in the survey. The overall response was 43 participants from various companies for a response rate of 17.2%. We did not know in advance if the randomly selected APICS members were involved with the e-business systems, so we asked that only those experienced with an implementation participate in the survey. Given this random sample and chance of participation, we were pleased to get the response rate that we experienced. We analyzed these data by using correlation models and one-way analysis of variance (ANOVA) to develop CE diagrams for overall e-business systems and each component of e-business. Based on the controlled error of the ANOVA process we use the CE diagram to depict the degree to which variables influence implementation success. It is noteworthy that the overall results tended to be carried into the component models but not with the same intensity.

It is important to note that the correlation models are measuring a fundamentally different relationship than the ANOVA. Correlation measures the degree of agreement between our key variable scale and the overall success score reported by the respondents. ANOVA is used to determine if there are significantly different success scores explained by categories of independent variables. While significant and similar findings in both models are possible, it is also possible that the models will reveal slightly different results that must be researched more carefully. We acknowledge that repeatedly using the bivariate correlation model reduces the power of the test, but our goal here was not a test of hypotheses as much a simple indication

Exhibit 3. Key Success Variables Uncovered by Interviews and Case Studies

Key Variables for E-Business Implementation	Variable Name in Table 1
Core Issues	
>Schedule reliability	SCHEDULE
>Budget reliability	BUDGET
>Realistic business expectations	EXPECT
>Sufficient implementation time	IMPLMNT
>Vendor-consultant relationship	V-RELATN
>Compatibility with legacy systems	COMPTBLE
>Management support	MGT-SPT
Implementation Team Skills	
>Communication skills	CON-INTP
>Full-time assignment	FT-COMM
>Cross-functional skills	CRS-FC
>Interpersonal trust	MU-TRUST
>Project management skills	PRO-MGMT
>Experience	EXPER
Vendor Consultant Skills	
>Business process knowledge	VEN-BPK
>Experience	VEN-EXP
>Interpersonal skills	VEN-INTP
>Communication skills	VEN-COMM
Outside (Third-Party, 3P) Consultant Skills	
>Software product knowledge	CON-SPK
>Experience	CONS-EX
>Interpersonal skills	CON-INTP
>Communication skills	CON-COMM

of association between the success criteria and the key drivers. ANOVA is a much more controlled experimental procedure for this research and we combine the indications of correlation with the statistically significant relations from ANOVA to build a database of "votes" that summarize the number of times a key implementation variable is found to be related to each of the three e-business components. We show the CE models for both the correlation and ANOVA methods for the overall data in this paper. We use the tallied "votes" to recommend whether or not a key implementation variable is truly on the implementation roadmap. We summarize the results for overall e-business systems and each component of e-business below.

Survey Development Process

Our research purpose was to gather the inputs about the e-business systems performance review from various companies who had implemented or are implementing ERP, SCM, or e-commerce. The survey development processes began with the definition of key success criteria and variables based on literature, case studies and interviews with industries (see Exhibits 2 and 3). We developed a survey instrument using these variables and key success criteria and divided the survey into five parts. The first part was designed to capture companies' general e-business systems information. The second part asks how companies provide support and training to implement e-business systems. The third part asks companies to evaluate the third-party consultants and vendor consultants that they used. The fourth section was the implementation evaluation, and the fifth section was open-ended comments about their e-business systems.

Analysis Methods

We analyzed these data by using correlation models and one-way analysis of variance (ANOVA) from SPSS software and then developed CE diagrams for overall e-business systems and each component of e-business. The goal of this process was to identify the key success variables that should appear in the implementation roadmap.

Correlation Model. We used a simple bivariate correlation model to measure the degree of agreement between our survey key dimension scale and the overall success reported by the respondents. The equation for a correlation model is:

$$Y_i = f(X_{ij})$$

Where

Y = ratio of reported success criteria to total criteria for each group i

i = Overall, ERP, SCM, e-commerce, (i=1,2,3,4)

X_{ij}, j = Variables (schedule, budget, management support, consultant skills, etc.)

As Exhibit 2 indicates, the number of key success criteria between ERP, SCM, and e-commerce are different. ERP, for example, has nine success criteria and e-commerce has six criteria. Because we have a different number of implementation success criteria for ERP, SCM, and e-commerce in our survey, we used ratios instead of binary sums for our overall score of success—so an ERP system that achieved four of the list of ERP success criteria was scored as 4/9.

When analyzing the data by using a correlation model, we determine whether or not the variables have either positive or negative correlation with success scores. Our goal with correlation models is to simply uncover potential relationships—we used the significance levels of each test to determine the strength of a relationship. The strength is depicted on the CE model as the width of the fish-bone diagram connector. We did not seek an overall set of hypotheses tests, so we used the correlation model as a preliminary indicator.

One-Way Analysis of Variance (ANOVA). The ANOVA approach evaluates whether the group means of the dependent variables differ significantly from each other. In other words, an overall analysis of variance test is conducted to assess whether or not means of a dependent variable are significantly different among groups of explanatory variables. ANOVA is used in our research to determine if there are significantly different success scores explained by our suspected key variables in Exhibit 2.

The hypothesis for our study is as follows:

H_o: There is no significant variability in the Overall, ERP, SCM, or e-commerce success scores explained by key independent variables defined by our model.

The existence of significant relationships from either a correlation model or ANOVA perspective allows us to reject this hypothesis and suggests relationships that form the basis of an implementation roadmap. Once again, we use the significance level of each variable as an indicator of the strength of the relationship and render these relationships in a CE graphic. When using ANOVA the overall experiment error is controlled, so these results are in some ways more definitive than the correlation model.

Results

We first used one-sample t tests to evaluate the average of success scores reported in the survey for overall e-business and each individual component. Exhibit 4 shows the t test results.

The Success Score is calculated as the ratio of success criteria to total criteria for each type of implementation; therefore, the minimum would be zero and the maximum would be one. Zero indicates that implementing e-business systems did not help the company improve its performance based on any success criteria. One means that e-business systems helped the company achieve all success criteria. For Overall and ERP, the average success scores are 0.46 and 0.43, respectively. There are a total of 10 success criteria for ERP. A score of 0.43 means that implementing an ERP system benefited companies about four out of ten of the success criteria. For SCM and e-commerce, the average success scores are 0.62 and 0.52 respectively. We have 13 success criteria for SCM and 9 success criteria for e-commerce; therefore, an SCM system benefits our respondents up to 8 out of 13 of success criteria. E-commerce, on the other hand, helps them 5 out of 9 of success criteria.

Exhibit 5 shows the findings of the survey analysis that link key implementation variables in Exhibit 3 with success criterion in Exhibit 2.

1. Success Row: The numbers shown in the success row indicate the correlation between success scores and variables. Two results are revealed from this number: first, a positive

Exhibit 4. T-test Results for E-Business System Success

System	Number of Cases	Mean	SD	SE of Mean	95% CI Lower	95% CI Upper	t-value	df
OVERALL	43	0.44	0.33	0.05	0.35	0.56	9.05	42
ERP	30	0.43	0.32	0.06	0.31	0.55	7.25	29
SCM	7	0.62	0.38	0.16	0.22	1.01	3.96	5
e-Commerce	6	0.52	0.30	0.12	0.21	0.83	4.28	5

Exhibit 5. Overall Relationship of Success Factors and Key Variables

Variables	EXPECT	IMPLMNT	HOW_LONG	SCHEDULE	BUDGET	MGT_SPT
SUCCESS	-0.3731	-0.3944	-0.1346	-0.4471	0.438	-0.0522
Cases	(41)	(39)	(39)	(39)	(36)	(40)
Correlation	*P= 0.016*	*P= 0.013*	P= 0.414	*P= 0.004*	*P= 0.008*	P= 0.749
One-Way ANOVA	*P= 0.080*	*P= 0.048*	P=0.679	*P=0.017*	*P=0.0005*	P=0.833

Variables	CON_COMM	CON_INTP	CON_SPK	CONS_EX	COMPTBLE	V_RELATN
SUCCESS	-0.3066	-0.0771	-0.5254	-0.2163	-0.1351	0.1824
Cases	(23)	(23)	(24)	(24)	(37)	(12)
Correlation	P=0.155	P=0.726	*P= 0.008*	P= 0.310	P= 0.425	P= 0.570
One-Way ANOVA	P=0.207	P=0.571	*P=0.031*	*P= 0.059*	P=0.654	P=0.243

Variables	VEN_BPK	VEN_COMM	VEN_EXP	VEN_INTP	MU_TRUST	FT_COMM
SUCCESS	-0.3386	-0.0282	-0.139	-0.0485	-0.0134	0.0675
Cases	(25)	(25)	(22)	(25)	(37)	(38)
Correlation	*P= 0.098*	P= 0.894	P= 0.537	P= 0.818	P= 0.937	P= 0.687
One-Way ANOVA	P=0.251	P=0.414	P=0.622	P=0.943	P=0.537	P=0.443

Variables	PRO_MGMT	CRS_FC	COMMUN	EXPER
SUCCESS	-0.1888	0.1012	-0.1205	0.1881
Cases	(38)	(38)	(37)	(38)
Correlation	P= 0.256	P= 0.546	P= 0.477	P= 0.258
One-Way ANOVA	P=0.638	P=0.833	P=0.331	

*Italic items are significant at the p < .1 level

number means the higher the level of variables, the higher the success scores; second, the larger the correlation number, the stronger the correlation between success scores and variables. On the other hand, negative numbers indicate higher levels of variables and lower success scores. For instance, on the budget column, the correlation number between budget and success score is 0.438; therefore, we know the correlation between success scores and budget reliability is a moderately positive correlation. Specifically, the more accurate the budget reliability in our survey questionnaire (1 - significantly over budget, 2 - moderately over budget, 3 - on budget, 4 - moderately under budget, 5 - significantly under budget), the bigger the success scores. In other words, when companies' e-business systems implementation budget is either moderately or significantly under budget, their success scores for implementing an e-business system would be higher.

2. Cases Row: The cases row indicates how many respondents answered the question.
3. Correlation Row: On the correlation row, p-value reveals our level of confidence in saying that the variables are correlated with success scores. In our research, we set the significant level at 10%. In other words, p-value = 0.10 for the overall guide to interpret our result; therefore, when the variable's p-value is less than 0.1, we could say that we have more than 90% confidence that the variable has a strong correlation with success score in our correlation model. When p-value is less than 0.20 or 0.30, the correlation between the

variable and success score is either moderate or weak. For instance, the p-value = 0.004 between schedule and success score; therefore, we have 99.6% confidence that there is a correlation between schedule and success. The correlation model only revealed, however, a correlation between the variable and success score; it did not reveal if there are significantly different success scores explained by variables. This is why we used one-way ANOVA analysis to find out if there are significantly different success scores explained by variables.

4. One-Way ANOVA Row: In one-way ANOVA analysis, we used the same significant level as our guide to reject or accept our hypotheses. The hypotheses we made on our research are that there is no significant variability in e-business success criteria explained by key independent variables defined by our model. When the variable's p-value is less than 0.10, we reject the hypotheses. In other words, there is significant variability in e-business success criteria explained by key independent variables.

Overall Results. The analysis of all e-business survey data lumps all types of implementations into a single model. Exhibit 3 provides the statistical summary of correlation and ANOVA analysis. We use p-values to indicate the level of confidence that a variable is in fact related to overall project success. A p-value of 5% indicates that there is 5% or less chance that this variable is not significantly related to our overall implementation success scores. We use the significant level =10%. In other words, p-value = 0.10, to set the threshold for significant results; therefore, when the p-value of a variable is less than 0.10, we could say that we have more than 90% confidence that the variable has a strong relationship in either the correlation or ANOVA models. When the p-value of a variable is greater than 0.1 but less that 0.2 or 0.3, the correlation between the variable and success score are either moderate or weak.

The overall e-business correlation CE diagram in Exhibit 7 reveals that six significant variables have strong correlations with success score (p-value < 0.05). These six significant variables are schedule reliability, budget reliability, 3P consultant system process knowledge, vender's business process knowledge, systems implementation time, and companies' expectations. The communication skill of the 3P consultant shows moderate correlation with success score (p-value < 0.20). In Exhibit 8 the ANOVA CE model has one more significant variable —implementation team's e-business experience—that does not show up in the correlation analysis.

Exhibits 7 and 8 depict graphically what was found to be statistically significant and provide the basis of the proposed

Exhibit 6. Summary Statistical Results

Variables	Cases	Correlation P-Value	One-Way ANOVA P-Value
Company expectations	41	*0.016*	*0.0800*
Implementation time	39	*0.013*	*0.0480*
Running time	39	0.414	0.6791
Schedule reliability	39	*0.004*	*0.0179*
Budget reliability	36	*0.008*	*0.0005*
Top management support	40	0.749	0.8363
Third-party consultant communication skills	23	0.155	0.2073
3P interpersonal skills	23	0.726	0.5711
3P system process knowledge	24	*0.008*	*0.0318*
3P experience	24	0.310	*0.0595*
System compatibility	37	0.425	0.6542
Vendor and consultant relationship	12	0.570	0.2433
Vendor business process knowledge	25	*0.098*	0.2510
Vendor communication skills	25	0.849	0.4154
Vendor experience	22	0.537	0.6224
Vendor interpersonal skills	25	0.818	0.9439
Implementation team mutual trust	37	0.937	0.5371
Team gull-time commitment	38	0.687	0.4430
Team project management skills	38	0.256	0.6387
Team cross-function knowledge	38	0.546	0.8330
Team communication skills	37	0.477	0.3316
Team e-business experience	38	0.258	*0.0879*

*Italic items are significant at the p < .1 level

Exhibit 7. Overall E-Business Correlation CE Diagram

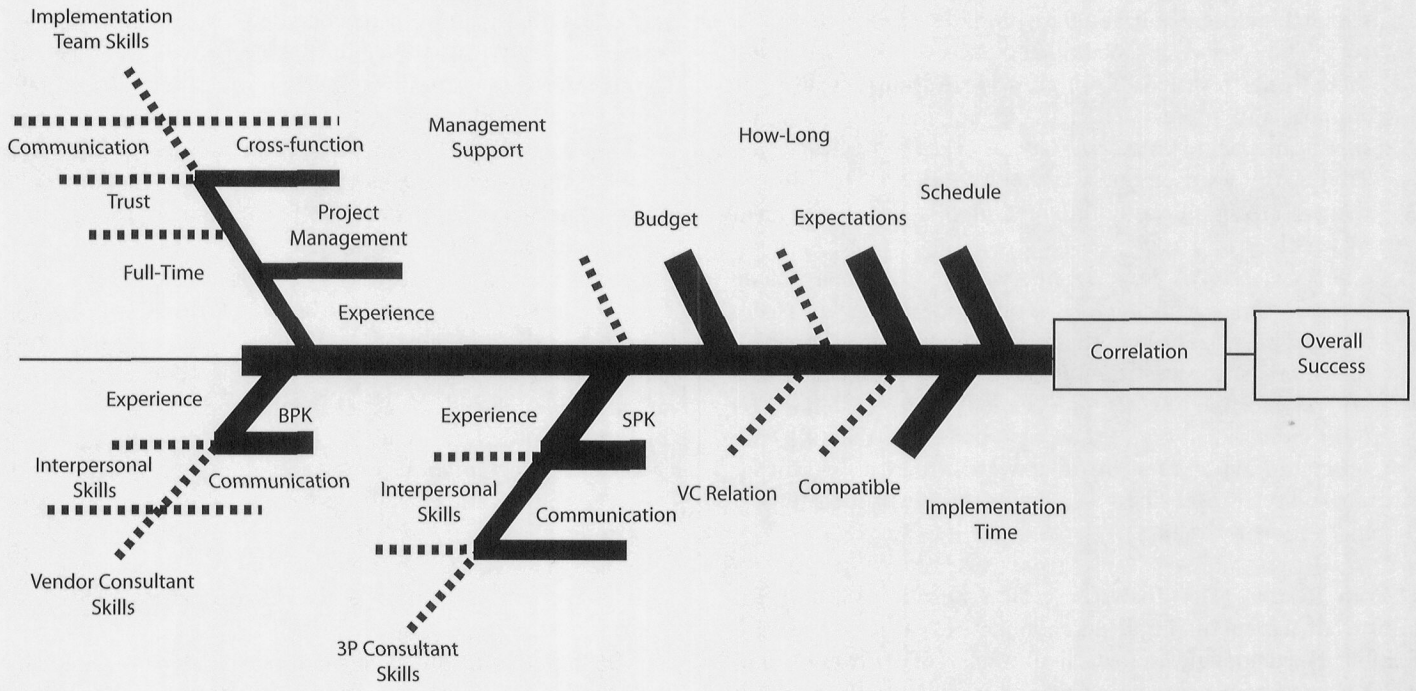
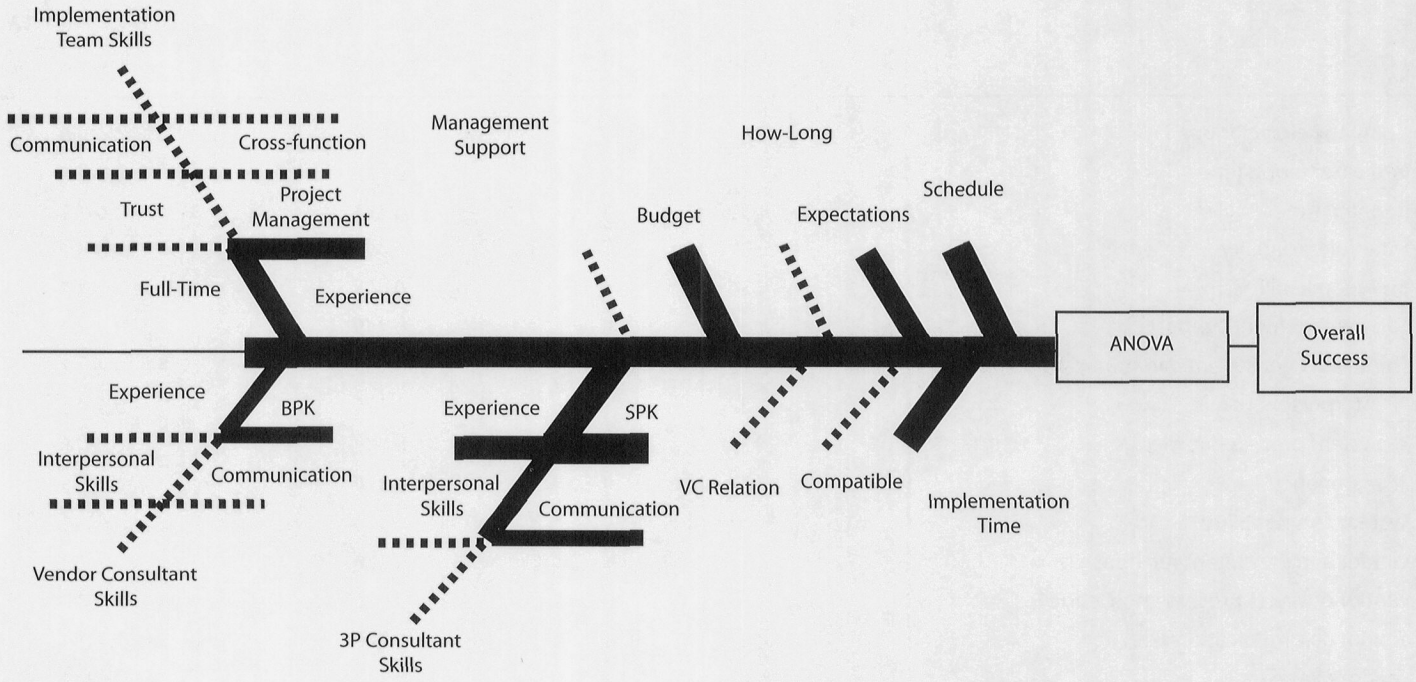


Exhibit 8. Overall E-Business ANOVA CE Diagram



implementation roadmap. Details for the components of e-business that are not depicted in this article are reviewed next.

Enterprise Resource Planning (ERP). Both ERP correlation and ANOVA CE models indicate four significant variables that have strong correlations with ERP success score—budget reliability, schedule reliability, 3P consultant's system process knowledge, and companies' expectations. Consultants' implementation experience and communications skills show a moderate correlation with successful ERP system implementation.

Supply Chain Management (SCM). In SCM, only budget reliability shows a strong correlation with successful SCM system implementation. Schedule reliability, implementation time, implementation team's e-business experience, and vendor's business process knowledge have moderate correlation with success; however, in ANOVA CE analysis, budget reliability, system implementation time, schedule reliability, vendor's business process knowledge, and companies' expectations are the most significant factors that contribute to implement success. Implementation team's e-business experience is a moderately significant factor.

e-Commerce. Budget reliability and schedule reliability are significant or moderately significant in the overall, ERP, and SCM models; however, they did not show significant correlation in the e-commerce model. Instead, the cross-function skill of implementation team, 3P consultant's system process knowledge, 3P consultant's implementation experience, and system implementation time are significantly correlated with success implementation. In the ANOVA CE, communication skill of the implementation team is significant.

We aggregated the significant variables for each component by indicating how many times they appear in CE diagrams. Exhibit 9 shows the frequency of key factor intensity. The intensity is the count of the times the factor was significantly related to implementation success in the survey when overall, supply chain, e-commerce and ERP systems were analyzed. The maximum intensity would be 2 tests x 4 samples to yield an 8. These key factors are now used to construct the overall implementation roadmap.

Pareto analysis helps to identify the most important effects and causes so that we can prioritize and focus on the main causes. In this research, we use Pareto analysis to interpret the relationship between significant variables and overall success scores. We can see that budget reliability, the system process knowledge of third party consultants, company's expectations, implementation time, schedule reliability, and the experience and competence of third party consultants constitute 80% of the overall success scores. We suggest that the majority of the overall success scores depend on these six significant variables.

Proposed Roadmap

We used these findings of significant variables to formulate a graphical roadmap that indicates when and where these success factors might appear and how a firm might manage the implementation process (Exhibit 10). Four principle stages appear in our e-business roadmap: planning, development, implementation and testing. The average e-business implementation time is 9 to 18 months (AMR, 2001). The solid lines with arrows show the flow of the roadmap. An end sign is not shown in the roadmap because e-business system implementations are endless projects. Firms need to frequently monitor and maintain their e-business systems as their business processes change; therefore, we show in Stage III and Stage IV that implementation and testing should be connected as an endless loop.

The component model described in Exhibit 1 and the roadmap in Exhibit 10 jointly provide a taxonomy for system implementation. What is suggested is a systems development concept that partitions the effort into stages with key signposts that the survey data reveal as key leading indicators of success. The role of teamwork and scheduling is well-documented in many sources; however some signposts deserve special attention in an e-business context.

Companies' Expectations. Companies' expectations appear in the planning and testing stages. Five out of eight of our e-business CE diagrams show that the company's realistic expectations are a significant variable to overall success scores. In the planning stage, the first things a firm should examine carefully are their expectations. They should consider organizational needs above organizational wants. Moreover, they need to have a direction for where they are going and how e-business systems may help. A firm should seek clear and unambiguous answers from vendors. According to the interviews with some companies, a vendor typically promises results far exceeding the product's capability and design.

One of the main reasons for implementing e-business systems is to gain competitive advantage. A firm should understand the benefits of e-business and then evaluate their organization to determine their desired organizational benefits. A firm should list their expectations and establish a clear initial vision. Vendors should not dictate company goals and objectives; rather these things need to be developed internally. A company's expectations, therefore, appear in the testing stage again because the company will evaluate and check whether or not the system meets the expectations they set in the early planning stage—expectations

Exhibit 9. Significant Variables for Implementation Success

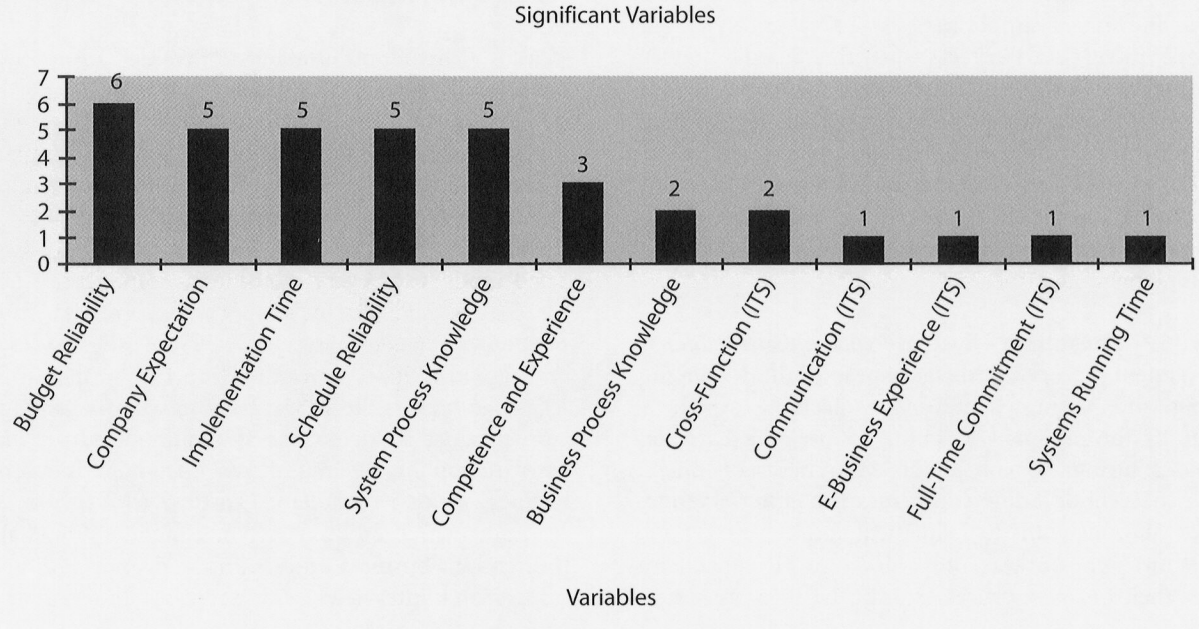
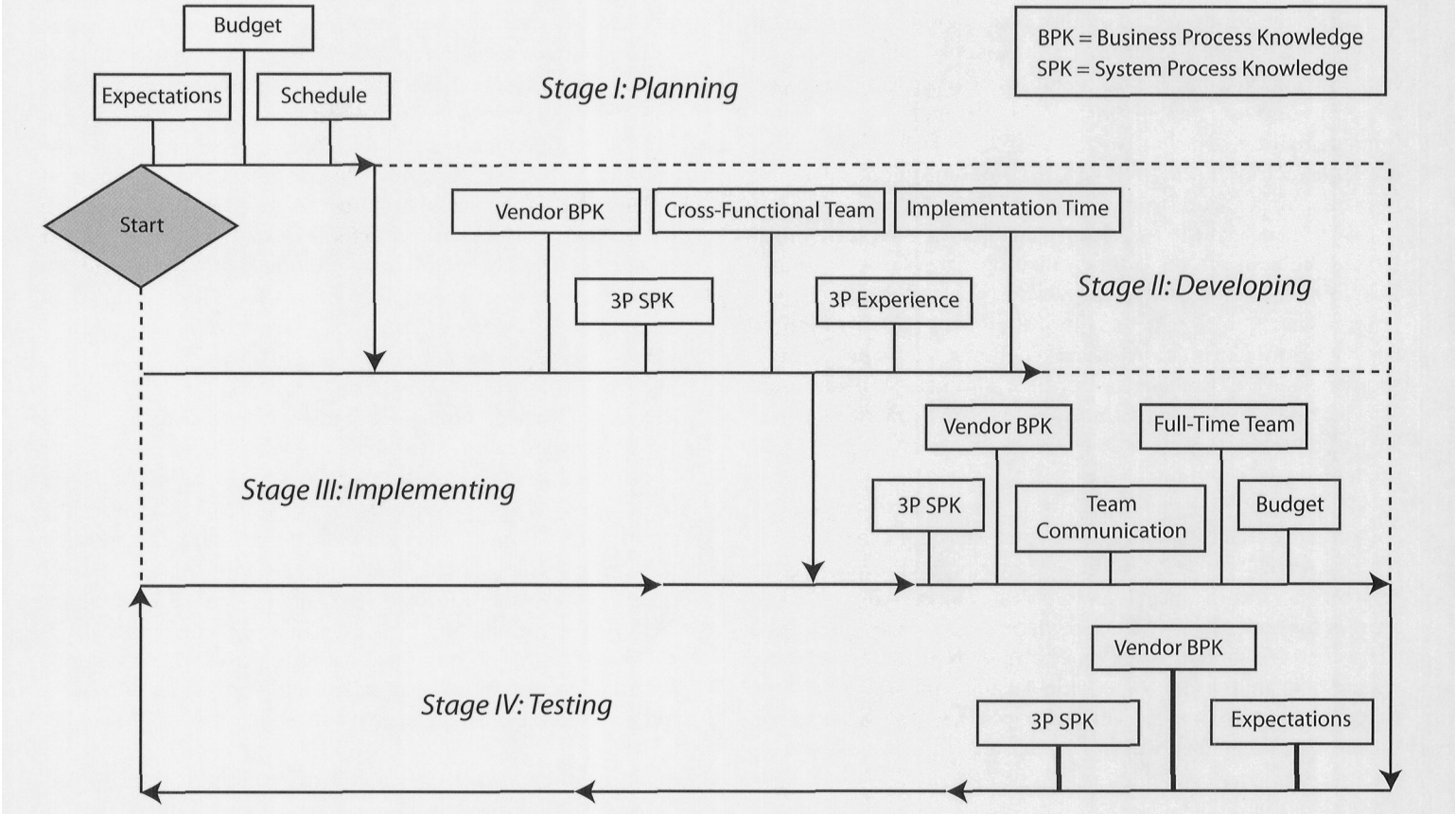


Exhibit 10. An E-Business Implementation Roadmap



that the company developed based on their needs, not the expectations defined by the vendor.

Budget Reliability. Budget reliability appears in the planning and implementing stages and is a most significant success factor. Fifty-seven percent of our respondents indicate their actual implementation budgets are either significantly or moderately over projection. The key seems to be reliable cost estimates rather than low-cost projects. Firms quickly lose faith in implementations with significant cost overruns. It appears that many organizations jumped onto the e-business parade with minimal financial metrics. Even the use of simple net present value (NPV) and return on investment (ROI) criteria when formulating budgets would be a major step forward. Amazingly, few companies in our analysis invested much time in even basic financial planning! Budget reliability appears in the implementing stage because the firm will need to review cost estimates and changing technology. Funds will also be allocated for training and education during this stage, and these requirements tend to evolve and change as the system implementation matures.

Third-Party (3P) Consultant's System Process Knowledge. 3P Consultant's system process knowledge appears in the developing, implementing and testing stages. After deciding which e-business vendor the company is going to use, the company might consider hiring 3P consultants who have a strategic alliance with the vendor. Some companies use either a vendor consultant or 3P consultant to help them implement systems (some companies hire both). Companies hire 3P consultants to reengineer their business processes to fit the software system they intend to implement. One of the advantages of using 3P consultants is the familiarity associated with the vendor's software system.

In the implementing stage, companies will need 3P consultant system process knowledge even more than in the development stage. The 3P consultant may need to modify the company's business processes to match the e-business software systems. When poor test results materialize, strong commitments from 3P and vendor consultants are essential. Both the company and 3P consultants should understand that implementing an e-business system successfully is a win-win situation.

Vendor Consultant Business Process Knowledge. Vendor consultant's business process knowledge appears in the developing, implementing and testing stages. Companies first need to select an e-business system vendor. Companies should understand that high market share e-business vendors may not guarantee that they can implement the systems successfully. In the Hershey and SAP case (Stedman, 2000), Hershey used top-rated vendors for every e-business component. They used SAP for ERP, Manugistics for supply chain, and Siebel for customer relationship management; however, the e-business system failed and caused Hershey's profit to drop 19% in the third quarter of 1999. We suggest, however, that companies examine a vendor's core product to determine if requirements are met. Careful construction of a requirements document is essential, and a business process consultant can be a wise investment early in the implementation lifecycle. The company should also examine the vendor's business process knowledge. According to our case studies and interviews with industry, the vendor consultant

who lacks business process knowledge will dramatically increase implementation difficulties.

Although vendors claim their products can be customized during the implementing stage, the majority of our respondents suggest keeping "the system clean and standard." The more customization allowed, the more complications arise in the system. Customization also increases the difficulties when upgrading the system. The vendor consultant plays an important role in the implementing stage not only because of their technical skills, but also because of their advice on business processes.

The role that the vendor consultant plays in the testing stage is more important than 3P consultants or the internal company team. The technical obstacles with either hardware or software need to be overcome. Additionally, the vendor consultant is responsible for understanding the system specifications completely. Requirement traceability becomes critical if performance features are modified or if key design decisions are altered.

It is noteworthy to consider the ownership of an e-business implementation. Usually, managers from the IT department and other related departments own the e-business implementation project; however, due to lack of either e-business software or cross-functional knowledge of managers, the vendors take charge of the e-business implementation instead of the internal company team. It is important that the internal company team create a learning environment that encourages the team members to continue learning and adapting during the change process.

Conclusion

Our research results have helped uncover the key variables that contribute to successful e-business implementation. It is clear that some variables, like companies' expectations, budget reliability and schedule reliability, are major factors that consistently appear in all components and across both CE modeling techniques. It is also clear that each component of e-business can be quite distinct in its implementation and consequently in its success factors. We suggest a taxonomy where e-business components can be related to one another and a simple implementation roadmap. We indicate when and where significant variables appear and how a firm might manage the implementation process. Clearly, the research hypothesis is rejected and we conclude that several of the independent variables in Exhibit 2 significantly explain the success of an e-business implementation.

There has been some recent research to support our conclusion. A case study at Texas Instruments points out that the standardization of internal processes, user expectations and important information technology systems are the foundation for the success of ERP implementation (Sarkis and Sundarraj, 2003). Another research paper indicates ERP implementation issues such as system adaptation, complexity, and organization adaptation did support our research in independent variables (company expectation, system process knowledge) that significantly explain the success of an e-business implementation (Luo and Strong, 2004).

It is convenient to think of e-business system implementation as a change process on a large scale. The implementation of an e-business system touches just about every aspect of a firm's operations even when small individual components are put into place. The adoption of one component tends to lead to others over time until most firms are intricately dependent on the underlying information technology in order to operate. The emergence of customer relation management, strategic enterprise management, data warehousing, and online analytic processing depends on lower level e-business implementation. We foresee a time when an e-business system will not be a collection of components as suggested in Exhibit 1 but rather a pyramid of layers of implementation that builds upon one another. Certainly, e-business implementations are costly and complex undertakings. We conclude that the evidence generated by successful and failed experience can be used to understand this management challenge so that a method of implementation that minimizes risk can be shared.

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