ERP System and Implementation-Process Benefits: Implications for B2B E-Procurement

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Abstract

Although a considerable amount of documentation has been published on the alleged benefits of Enterprise Resource Planning (ERP) systems, rigorous theoretically supported research into this topic has been limited. Furthermore, with the recent popularity of new technologies such as those supporting Business-to-Business (B2B) e-procurement, many have begun to loose focus of the underlying infrastructure upon which these new technologies depend, and which ERP systems provide. The aim of this paper is to provide a theoretical foundation for the consideration of the criticality of ERP system implementations with regards to the effective utilization of up-and-coming technologies. We approach this task in two steps. First we apply the theory of Swift, Even Flow to illustrate the potential impact that both the *Product* and *Process* of ERP implementation can have on overall operational effectiveness. We then utilize the theory of Resource Dependency to suggest the impact that such improved effectiveness might have on the ability of a firm to take advantage of B2B e-procurement technologies. An investigation of 61 B2B success cases reveals that the extent to which firms witness savings through such procurement is dependent not only on the presence of an implemented ERP system but also on the length of time such systems have been present and active.

Keywords: Internet; Purchasing; ERP; Strategic Planning; Theory

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1. Introduction

Over the last decade we have seen both the boom and the malaise of the ERP market. Revenues from enterprise resource applications hit $16.6 billion in 1998, a 39% increase from the previous year and by May of 1999 predictions of a $60+ billion ERP market were being made (CMP Net, 1999). Some vendors had seen years of sustained 60% growth rates. Yet declining sales and falling profits in the second quarter of 1999, spurred trigger-happy analysts to declare that the death of the ERP market was soon to come (Conners, 1999). Disinterest with ERP implementations following Y2K refurbishments, and the new love of electronic commerce and extended enterprise applications continued to feed this fire throughout the first half of this year. The more than ten-fold increase in B2B transactions from 1997, when already $7.4 billion was reported, to that anticipated for the year 2000 has lead many IT managers to rethink their overall strategies (Marshal, 1999). Moreover, with budgets and resources focused on these second phase technologies, few firms have begun to realize the critical role that ERP system implementations may have on the effectiveness of such plans.

Because of the relatively early stage of this revolution, intrepid firms are faced with several strategic questions. One of these is whether to utilize e-commerce extensions designed by the developers of ERP systems in-place, or to invest in packages developed by focused vendors that have established themselves through their advancements in e-commerce. From one perspective, ERP systems have traditionally dealt with back-office functions, while e-business functions typically relate to external activities between suppliers and customers. Some therefore view the basic mentality of ERP vendors as misdirected with regards to "new economy" projects. At the same time however, the effectiveness of extended applications can greatly depend on both the appropriateness of the underlying information infrastructure provided by ERP systems and the ability to efficiently and accurately transfer information between extensions and the ERP infrastructure (Oliver, 1999). An intimate understanding of the data and interface architecture of such systems might suggest that ERP vendors in fact provide more advantageous sources for e-commerce applications.

Another question goes far beyond the issue of vendor loyalty. With the pressure of entry into the e-commerce market now threatening the pre-emption of many other IT projects, the question of whether to postpone or even drop plans for ERP implementation arises. This may be a particularly volatile issue for small and medium sized firms that have traditionally been late adopters of advanced technologies, due to their inherent resource constraints. The appeal of reaching a larger market and the deceptiveness of costs involved in many B2B ventures makes such considerations not only more complicated but also increasingly time-sensitive.

The aim of the present research is to illustrate how both the process and product of ERP system implementation can facilitate and increase the effectiveness of future e-commerce projects. We focus here on the emergence of B2B applications. Established theory forms the basis of our main arguments for the importance of a working ERP infrastructure. Such a discussion begins with the consideration of existing academic literature on the topic of ERP. We then build on this discussion by applying theory in related Operations Management areas to support postulations of ERP implementation effects. Lastly we provide the results of an informal survey of firms that have been active in B2B exchanges and compare success rates between those equipped with an in-house ERP system and those without.

2. Theory Behind the Benefits

Anecdotal reports on the benefits of ERP systems are now far from rare in the popular press. However the majority of these reports present little beyond high-level ambiguous commentaries, coming across more like hastily formulated sales pitches than anything else. This of course is no surprise given the shear complexity and ubiquitous nature of ERP systems. Few technical writers have had enough time and experience with specific packages and users to provide a vivid story of the mechanisms behind the benefits reaped. The same holds for the majority of the business academic community. Fortunately, academic efforts to rigorously spell out the theoretical nature of ERP benefits are starting to surface. Several researchers now view ERP systems not only from a benefits perspective, but more importantly as a necessity for maintaining future competitive advantage (Ndede-Amadi and Mykytyn, 1999).

Such a view is based on the idea that a ERP system is not simply a tool that provides a single output, but rather an infrastructure that supports the capabilities of all other information tools and processes utilized by a firm. In a recent series of case studies, Palaniswamy and Tyler emphasize this point (2000). The authors state that ERP systems provide critical functionality by integrating information technologies relevant throughout the enterprise. Furthermore, the process of ERP system implementation forces organizations to increase their understanding of their core capabilities and make necessary changes to business processes that may otherwise have been ignored. Therefore, not only the package but also the process of implementation should be viewed as an opportunity to attain and maintain positions as market leaders.

This type of long-term strategic perspective is certainly not new to the greater realm of IT, with theorists framing "opportunity" as a relevant justification for adoption since the 1980's (Parker 1988). In fact when one goes back to the origins of ERP system concepts, it is obvious that such packages emerged from an interest to develop inter-organizational systems (IOSs), rather than intra-organizational ones (Swenseth 1999). The inevitable difficulties associated with attempting to jump directly into effective IOSs given the wide variety of independent business systems within a given firm forced many intrepid developers to shift their focus to organizing information on an enterprise level as a priority. This task soon proved daunting in itself, thus emphasizing value that expertise in the development of ERP systems might have in a market setting where demand for such internal data integration was clear. Only now that ERP systems are becoming well established are many of the initial objectives of the IOS concept even possible.

Perhaps one of the best analogies that can be made regarding the criticality of ERP systems to alternate IT efforts that inevitably depend on them comes from the experience of research in the field of Operations Management. Long before the implementation and integration of information technology emerged as an issue, the adoption of new manufacturing technologies was being studied. With multiple new processing technologies becoming available, the timing of such adoptions was often associated with anecdotal evidence of performance implications. As an example, Vonderembse et al. recently provided an extremely insightful work that outlined the experience of firms adopting automated technologies in the industrial age (1997). Traditionally the approach had been to select 'best' methods to automate specific tasks and then attempt to integrated these 'islands of automation' to ensure integration. In contrast, more successful approaches witnessed in the post-industrial age have involved widespread attempts to integrate and rationalize operations first, prior to automating those processes that can most benefit. The lesson for IT planners should be a similar one. By first focusing on the establishment of a logical and effective infrastructure, the road for effective inter-organizational extensions can be much clearer. Future plans are therefore dependent on the understanding of benefits made available through ERP implementation. A discussion of the possible source of these benefits subsequently becomes natural.

1.1. Sources of Benefit

In general, the issues focused on in the discussion of benefits can be categorized as either emphasizing the *Product* involved in the ERP implementation (e.g. the ERP system itself) or the *Process* associated with the implementation (e.g. Business Process Reengineering (BPR) and System development/modification). Specifications of the *Product* relate to the vendor and version of the system implemented, but also, perhaps more importantly, to the structure of the system relative to enterprise-wide operations. The existence of a single common database and the use of standardized user and system interface forms are each facets of this structure. Furthermore, it is widely held that the design of such architecture enables firms to more easily tie system acquisitions to their corporate needs, rather than facilitating costly expenditures in badly designed business procedures. (Harrington, 1991; Mandrish, 1995)

The *Process* characteristic of the system implementation is equally relevant. At this point it is relatively well understood that the choices of implementation strategies available to firms adopting ERP systems constitute a spectrum bounded by the sole use of business process-driven

system customization efforts at one extreme, and the sole use of system-driven BPR at the other. This spectrum is depicted in Figure 1. The basic reasons behind the existence of this spectrum stem from the fact that no two business use the exact same business model, and therefore a vendor's design of a system that provides a simultaneously natural fit to all potential corporate clients is impractical. When firms are confident that the business processes they currently utilize are correct and in fact provide them with a competitive advantage over their competitors, they may be unwilling to change. Instead, the system adopted may require extensive customization to fit these unique business processes. At the other extreme, businesses convinced of the merits of the ERP system in question, and already dubious of their own legacy business processes may encourage internal restructuring to fit the proposed "best practices" that some ERP systems claim to represent. The majority of reportedly "successful" implementation strategies fall somewhere between these extremes.

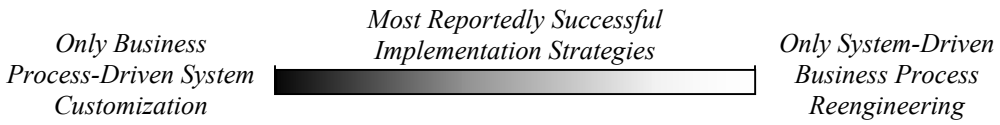

Figure 1 - Characteristic Spectrum of ERP System Implementation Processes

A number of benefits may be naturally inherent to the *Process* of implementation. Of course the most obvious stem from the elimination of redundant or unnecessary processes, improved resource allocations and system-wide standardizations. However, depending on where in the above spectrum a particular strategy lays, a firm may be able to reap considerable benefits from increases in the knowledge base of its personnel and from the overall corporate awareness of the firm. This garnished expertise is analogous to the concept of ERP competency proposed by Stratman and Roth (1999). By their definition, ERP competence includes the consideration of such capabilities as effective system maintenance and use, as well as the ability to recognize opportunities for system development and innovation. The works of Bingi et al. (1999) and Bendoly (2000) provide similar arguments regarding the benefits of the implementation process by focusing on support (morale) building activities that may exist as side effects to the implementation.

1.2. Linkages to Existing Theory

However logical they may seem, these issues have not yet been studied in depth academically. Indeed, there remains a deficit of research focused on the examination of the benefits accrued through ERP implementation. For many researchers, the question is "where to start?". In a recent commentary on ERP research, Allen Lee, the current Editor-in-Chief of MIS Quarterly, suggested a call for studies designed not to purely replicate existing theory, but to "revise, refine or refute existing significant theories" (Lee, 2000). He furthermore suggested that several established studies might be revisited within the unexplored contexts characteristic of ERP implementations. The notion of revisiting past research to provide a foundation for an emerging research stream is both logical and fortuitous from the perspective of the field of Operations Management, where frameworks and theory have been prolifically applied.

With this very thought in mind, it is therefore interesting to note the analogy of the two ERP implementation dimensions described above with other dimensions characteristic of well established OM research frameworks, most notably the Product-Process matrix of Hayes and Wheelwright (1979a,b). Of course in the traditional definition of this matrix, the term "Product" was used to represent that which was being produced by the "Process" utilized by a firm. In contrast, the "*Product*" in question here is the ERP system made functional by the "*Process*" of implementation utilized by a firm. Beyond providing a basic structure to describe anecdotal relationships between *Product* and *Process* decisions, the Hayes-Wheelwright framework also opened up the potential for empirical verification and served to encourage theory building on the topic that could later support extended research. One of the most important empirical studies on the subject was provided by Safizadeh et. al. (1996), who not only verified the tendency for firms to fall along a strategic diagonal in this matrix, but also the benefits that such positions provided firms relative to those operating in poorly aligned off-diagonal positions.

The development of a similar framework has also been recently considered within the context of ERP system decisions. Jacobs and Whybark's (2000) framework consisted of two specific sub-dimensions of the ERP *Product* concept, though arguments can be made which link such facets directly to *Process* implications as well. Again, although based purely on anecdotal evidence, this framework provided the impetus for both empirical verification and theory driven research extensions. A study performed by Bendoly and Jacobs was designed with these very goals in mind (Working). These authors also found that firms operating at off-diagonal positions of the matrix showed lower performance levels than those with more aligned strategies. The

implications of strategic alignment between operational *Processes* and the IT *Product* were also studied in this regard.

Therefore, although such frameworks risk a potential argument for not being representative of "theory" in themselves, their reference in empirical studies clearly alludes to the theoretical value of the dimensions that constitute them. Similarly the interpretations of *Product* and *Process* foci in emerging ERP research provide two intriguing windows for viewing existing theory. Following outlines provided by such authors as Schmenner and Swink (1998) we can consider a number of theoretical mechanisms drawn from OM research that have implications along both ERP *Product* and *Process* dimensions. To begin with, consider the Law of Variability. Schmenner and Swink describe this law by stating:

> "The greater the random variability, either demanded of the process or inherent in the process itself or in the items processed, the less productive the process is"

For the purpose of discussion, we might refocus this definition with specific regards to the ERP *Product* and *Process* contexts:

> "The greater the random variability, either demanded of the process or inherent in *the transactional and operational processes supported by an ERP system*, the less productive the process is"

The *Product* of an ERP implementation is most often characterized by a reduction in both the diversity of information storage mechanisms (e.g., one central database) and the interfaces necessary for conducting business transactions. Standardization inherent to the design of enterprise-wide applications permits user interfaces to remain comparable regardless of what business units are involved. This allows processing times to be more accurately estimated and hence improves the firms' ability to effectively allocate resources. Such variance reduction may also increase the ability of individual employees to communicate regarding critical business issues and the ability of technical personnel to make adjustments and maintain the system as a whole. From a mechanical standpoint, the standardization of computer-computer interfaces, besides eliminating unnecessary data translation protocols, simultaneously increases the ability to predict the amount of time

required to transfer large packets of information and reduces the potential for discrepancy among reports.

The *Process* of an ERP implementation, notably any reengineering effort involved, is also often associated with variance reduction with regards to a rationalization of the total number of processes used and the diversity of employee interpretations of corporate goals and operational requirements. These in turn assist in the reduction of variance in transaction processing time, especially non-value added components, that have been cited countless times as notable benefits to firms adopting ERP systems.

Continuing with this line of discussion, we can consider another law described by Schmenner and Swink: The Law of Bottlenecks, a variant of Goldratt's Theory of Constraints (1989). By their definition, this law states:

> "An operation's productivity is improved by eliminating or by better managing its bottlenecks. If a bottleneck cannot be eliminated in some way, say by adding capacity, productivity can be augmented by maintaining consistent production through it, if need be with long runs and few changeovers."

Again, even a slight modification can refocus this towards an ERP system orientation:

> "An operation's productivity is improved by eliminating or by better managing its bottlenecks. If a bottleneck cannot be eliminated in some way, *say by reducing the non-value added time of a transaction that precedes a physical process*, productivity can be augmented by maintaining consistent production through it, if need be with long runs and few changeovers."

Reduction in processing time, and variance associated with such time, made possible after ERP implementation, via BPR efforts for example, can also give rise to the elimination of process bottlenecks. Remarkable transaction time reductions, sometimes on the scale of 95%, represent considerable potential for such elimination. As mentioned above, this variance reduction can in turn greatly aid in the reduced impact of other bottlenecks that may remain unavoidable.

Lastly we can consider the merger of these two laws into what Schmenner and Swink refer to as the Theory of Swift, Even Flow. These authors describe this as follows:

> "The Theory of Swift, Even Flow holds that the more swift and even the flow of materials through a process, the more productive that process is. Thus productivity for any process… rises with the speed by which materials flow through the process, and it fails with increases in the variability associated with the flow, be that variability associated with the demand on the process or with steps in the process itself."

An understanding of this theory requires the consideration of three established notions. Two of these directly reference the Law of Variability and Bottlenecks described earlier. The third notion involves the distinction between value-added and non-value-added processing time. Efforts involved in moving materials, recording their specifications and transferring such information, are often considered examples of non-value-added time from a production standpoint. Furthermore, the creation of waste is considered non-value-added, encompassing such issues as overproduction, waiting, transportation, unnecessary processing steps, stocks, motion and defects (Hall, 1987). According to the Theory of Swift, Even Flow, the reduction or elimination of such waste allows material to flow more swiftly through a process, hence leading to higher levels of productivity. Since the rationalization of processes involved in BPR efforts, necessary in ERP implementations, may eliminate wasteful processes as well as reducing the diversity and variability in non-wasteful ones, the ERP implementation process may also be associated with waste reduction.

	Product Effects	**Process Effects**
Variability Reduction	*Common DB*: Elimination of redundancy and potential for multi-system data conflicts *Standardized Interfaces*: Reduction in variance in human-computer and computer-computer processing time	*Rationalization of Number of Business Procedures*: Less uncertainty as to how a transaction will be executed *Training/Education of Users*: Reduced variation in interpretations of corporate goals, operational priorities and transactional procedures

Bottleneck Reduction	*Common DB*: Tracking of processing times and simplified identification of potential enterprise-wide bottlenecks *Standardized Interfaces*: Significant reduction of time required for transactions, in some cases eliminating bottlenecks	*Rationalization of Number of Business Procedures*: Fewer processes make the identification of bottleneck sources easier, and allow for smoother reactive capacity adjustments *Training/Education of Users*: More workers have the ability to recognize bottlenecks
Waste Reduction	*Common DB*: Monitoring of specific forms of waste, and prioritization of waste by enterprise-wide cost implications *Standardized Interfaces*: Allowing easier comparability of inter-departmental sources of waste and hastens treatment	*Rationalization of Number of Business Procedures*: Elimination of unnecessary, redundant or waste-generating business sub-processes *Training/Education of Users*: More workers have the ability to recognize waste and future waste generating processes

Table 1 - ERP System Product and Implementation Process Effects on Swift, Even Flow

Therefore, as a whole we can expect associated BPR efforts that take place during ERP implementation to provide several benefits from the standpoint of the Theory of Swift, Even Flow. The same can be said from an ERP system *Product* perspective. Table 1 outlines just some of the effects suggested from each perspective as they relate to the three components of the Theory of Swift, Even Flow. If these theoretical benefits are obvious at various levels of a firm's operations, they may also be apparent in as far as the effectiveness of other supporting IT systems are concerned. After all, most IT systems are designed to support or extend existing operations, not to replace them. The current investigation develops from this very line of theory.

3. Postulation and Testing

Given the ability not only to cite anecdotal evidence of ERP benefits, but to also now link these benefits to established operational theory, a wide range of research questions arise. Are the direct impacts on operational efficiency made possible by ERP systems, in accordance with this theory, measurable? Can both *Product* and implementation *Process* benefits be distinguished? What indirect effects might be observable in terms of as the effectiveness of alternate technologies designed to enhance the performance of a firm? Our present interest is particularly with regards to this last question. Specifically, we consider the potential for these theoretic operational benefits to be reflected in savings observed through the use of business-to-business (B2B) procurement technologies.

The proliferation of B2B technologies has created quite a buzz over the last two years. In reality however, the evolution of B2B technologies has been long coming. Electronic Data Interchange (EDI) technologies, recognized by many as the forerunner of B2B marketplace concepts, have existed for two decades, though their popularity has remained limited due to number of complicating reasons (Kaefer and Bendoly, 2000). Beyond the basic element of electronic transaction, B2B marketplaces however are unique from traditional EDI systems in their ability to allow firms to advertise, auction off and bid for materials in a forum consisting of multiple firms simultaneously. By using the Internet as a foundation, these marketplaces break down market boundaries and introduce firms to potential partners they may have never known existed. In effect it allows the translation of hierarchical settings to those of true markets, as hypothesized by Malone, Yates and Benjamin (1987) in their groundbreaking electronic market hypothesis.

With the potential for significant savings and marketing opportunities, also comes the potential to garnish some of this new economy wealth by providing the backbone services and technologies that make B2B technologies possible. As a result, a myriad of dot-com start ups have rushed into the B2B technology and service provider market, along with an infamous pool of venture capital. ERP vendors, traditionally focused on back-office functionality have also joined this race. One often cited example is the case of SAP AG, currently the largest player in the ERP market with its R/3 system. Its introduction of mySAP.com in 1999 was the first of its thrusts into the greater realm of B2B e-commerce. SAP has already partnered with firms in such diverse industries as crude oil, plastics and healthcare to develop and launch on-line marketplaces supported by R/3 architecture (Gilbert, 2000). Discussions of the potential benefits of these sites have already been touted in numerous business trade journals.

Regardless of who has developed the technology, one might ask what is required for a firm to reap the most benefit from its involvement in a B2B marketplace environment? As a first prerequisite, one might expect that a sufficient amount of product information must be readily available to those dealt with in the exchange. The majority of such data focuses on inventory availability, quality, transportation mechanisms and pricing. By this argument, the most competent firms in such exchanges would be those whose data provided is both easily updateable and rationally applicable in a real-time global setting. And where does this data come from?

Predominantly, such data will originate from internal records that the firm maintains. This is where the potential role of ERP systems comes into play.

As proposed earlier, the theoretical foundation of Swift, Even flow provides a means of linking ERP *Product* and implementation *Process* benefits to operational efficiency. Looking closely, these benefits originate with the concept of variance reduction effects, and spill over into the potential for bottleneck and waste reduction benefits in turn. Since purchasing mechanisms are dependent on materials management policies however, the impact of variance reduction effects on requirements planning may also become obvious from a procurement cost perspective. These positive purchasing effects that uncertainty reductions in material requirements planning provide have been touched upon in several research pieces over the last decade. As an example, in Handfield's (1993) study of JIT purchasing success, he draws upon the Resource Dependency Theory to postulate how reductions in requirements uncertainty can reduce a firm's incentives to become dependent on a subset of suppliers. The capability to consider multiple suppliers in turn provides the purchasing firm with a considerable opportunity for cost reduction through bargaining, and hence reduces the benefits and likelihood of JIT adoption (Handfield, 1993; Pfeffer and Salanick, 1978). The results of Handfield's study in fact provide substantial support for this hypothesis. If ERP systems provide reductions in material requirements uncertainty, therefore, they may also be associated with an increased potential to benefit from the use of B2B marketplaces for Internet-based procurement. The following hypothesis is therefore formed:

H_0: *ERP system usage increases the potential for cost reductions associated with on-line procurement in B2B marketplaces.*

In an attempt to provide early verification of this postulate, we conducted an extensive review of success cases and customer testimonials provided by websites hosted by B2B vendors and market makers. In total, 72 cases were examined from the sites of 23 such providers. Although the sample itself was clearly biased in as far as the overall positive nature of benefits reported, our aim here was not to simply suggest that cost reduction was possible but rather that reports of cost reduction might reflect ERP usage. It was our belief that any market-driven bias in these numbers would neither mask nor accentuate the relative importance of this issue. As an additional step, to ensure that no product-package biases might exist, only cases in which ERP

systems were not mentioned were included in our analysis. Fortunately, this compensation reduced our useable sample size only moderately, to a total of 61 firms. For each of these remaining firms, cost reduction figures were either taken from direct quotes in the case documentation or press releases provided by these firms.

Because of limited informative nature of these cases, to obtain data on whether or not the firms in the reduced sample were in fact users of ERP we had to relay on alternate media sources. The article databases of ABI/Inform, EBSCO and the ERP Supersite were searched for key words relating to each firm and "ERP". Information regarding ERP implementation not obtainable through such searches were provided through either the web sites of these firms or e-mail correspondence with IT representatives. Through this process we were able to determine not only which firms were using ERP systems by the date of reported B2B savings, but also how long such firms had been using these systems.

Lastly we were concerned that since smaller firms were traditionally less likely to have experience using ERP systems, any potential findings might be construed as artifacts of firm volume effects. Therefore, we also collected annual sales revenue figures on each firm to serve as a potential control. Such figures were taken directly from financial profiles available through on-line public stock databases. A comparison of ERP and Non-ERP utilizing firms revealed that while reported B2B savings did appear to significantly differ, the magnitude of sales did not. This is true even at the 10% level, although the figures certainly come close. Table 2 provides the results of both independent sample t-Tests and Mann-Witney non-parametric comparisons between the two groups of firms.

	ERP	N	Mean	Median	SD	t-Test Sig.	M-W Sig.
B2BSAVE	Non-ERP Firms	23	8.44%	6.25%	0.07	*0.009*	*0.004*
	ERP Firms	38	14.60%	15.00%	0.06		
LNSALES	Non-ERP Firms	23	20.79	20.77	1.58	*0.102*	*0.115*
	ERP Firms	38	21.88	21.93	1.89		

Table 2 – Statistical Comparisons of ERP and Non-ERP Firms

The magnitude (log transform) of sales was used in this comparison since absolute figure distributions proved to be exceedingly right-skewed (Non-Normal at the 5% level via Kolmogorov-Smirnov tests for Normality). B2B Savings figures however did appear to roughly approximate Normality (again via K-S tests). The overall distribution of these values and box-

plots for the ERP and Non-ERP sub-samples are provided in Figure 2. As shown, the range for reported B2B savings was between 0% and 30%, with a mean around 12% overall. Again, the means depicted graphically in Figure 2 are analogous to those outlined in Table 2. Although these means appear to differ, the relatively larger variance in B2B savings among ERP firms suggested that a more in-depth examination of the effect of ERP usage might be required.

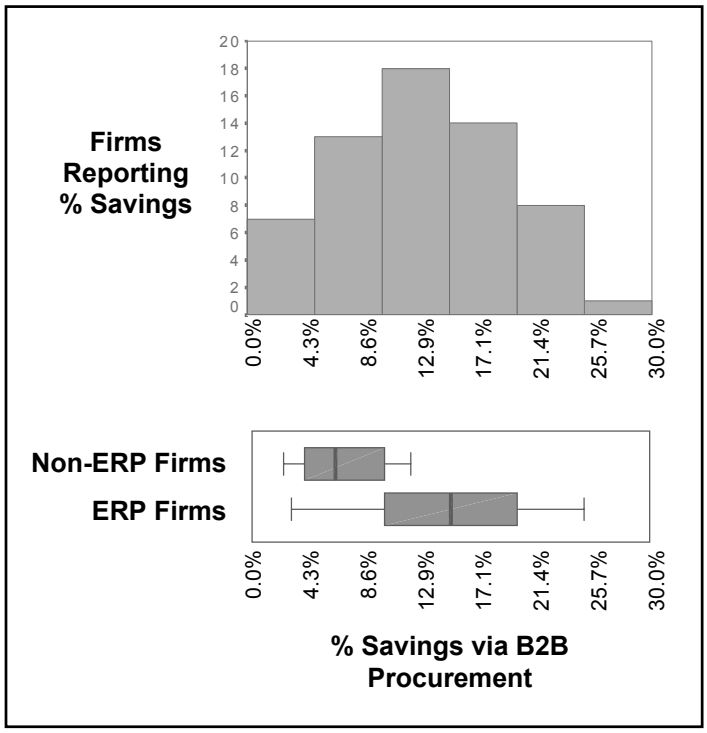

Figure 2 – Distribution of Firms Reporting B2B Procurement Savings

With the belief that the distribution of reported B2B savings approximated normality, we conducted two sets of regressions aimed at testing more directly the effect of ERP, as proposed in H_0. Given the knowledge that the relationship between annual sales and ERP usage, no matter how slight, might detract from the effect observed, a blocked approach was utilized. The independent variables in this regression therefore included both a binary variable representing ERP use and the natural log of annual sales revenues, the latter of which was entering in the second block of the regression. Table 3 provides these results. As shown, the use of ERP appears to increase average B2B savings by about 6.3% among firms in the sample. This is equivalent to the difference observed in Table 2, and is well in line with H_0. As revealed by the R^2 values, both blocked phases of the regression accounted for about 20% of the variance in B2B

savings reported. The addition of the annual sales term provided no significant improvement in the R^2 observed, and the coefficient on the ERP binary variables remained relatively stable (and significant at the 1% level in both blocks). Such a result lends further support to the mechanism represented in H_0.

	B	SE	t	Sig.	R^2	Sig. ΔR^2
Const	0.084	0.017	4.97	0.00	*0.195*	*0.009*
ERP	0.062	0.022	2.78	0.01		
Const	0.111	0.135	0.82	0.42		
ERP	0.063	0.024	2.68	0.01	*0.196*	*0.846*
LNSALES	-0.001	0.006	-0.20	0.85		

Table 3 – Regression Statistics for B2B Procurement Savings as a Function of ERP Use (Full Sample)

Given the data available, we also decided to test whether the number of years of ERP use had an impact on B2B savings. For such an analysis only those firms using ERP systems were considered. A blocked strategy was used here as well, with the first block including only the number of years of ERP usage as an independent variable, and the second block introducing the magnitude of sales revenue. The results of this regression are provided in Table 4. Here almost 28% of the variance in B2B savings observed in the ERP firm sub-sample was accounted for in both blocked phases. Once again, the addition of the annual sales term failed to provide significant improvements in the R^2, and the coefficient on the number of years of ERP usage remained stable (and significant at the 5% level in both blocks). Overall, the coefficient translates to roughly a 2% increase in B2B savings per additional year of ERP usage. Of course the interpretation of this effect needs to be a cautious one considering the relatively short time spans involved (the longest usage included was approximately 5 years). In sum, these results represent support not only for the original representation of H_0, but also for variants on this hypothesis.

	B	SE	t	Sig.	R^2	Sig. ΔR^2
Const	0.108	0.020	5.50	0.00	*0.276*	*0.021*
NYRSERP	0.019	0.008	2.55	0.02		
Const	0.120	0.142	0.85	0.41		
NYRSERP	0.019	0.008	2.45	0.03	*0.277*	*0.933*
LNSALES	-0.001	0.007	-0.08	0.93		

Table 4 – Regression Statistics for B2B Procurement Savings as a Function of Years of ERP Use (ERP Firms Only)

4. Conclusions and Future Research

The future role of ERP systems may be far more critical that the reasons for which they have traditionally been adopted. With the rapid emergence of wave after wave of new technologies, the availability of an effective infrastructure on which to build may be one of the most important factors that enable and sustain future competitive advantage. Furthermore, the lessons learned in the process of establishing this architecture may be invaluable in paving the way for technological innovations to come. This work has attempted to illustrate that the benefits of ERP systems, beyond well-documented anecdotal evidence, are logically rooted in theory. Specifically theory in the field of Operations Management appears to provide a particularly rich and appropriate foundation for the consideration of the benefits introduced by ERP system implementation. Such theory can serve as a conduit to link the presence of the infrastructure provided by an ERP system to the effectiveness of emerging information technologies.

Building off of the theories of Swift, Even Flow and Resource Dependency, we hypothesized the effects that both the *Product* and the *Process* of an ERP system implementation could have on the effectiveness of B2B e-procurement. Our analysis of 85 success cases in fact provides early support for such a hypothesis in a number of ways. First of all, we find that firms using ERP systems on average reap greater savings through B2B procurement than do firms without ERP systems. Secondly, we find that firms with a longer history of ERP usage are also capable of garnishing greater savings through such e-procurement. While suggestive, the data considered may not be sufficient to exclude the potential effects of a number of other mitigating variables that might confound the true mechanisms at hand. In reality the consideration of additional factors may either negate or lend even more support to this postulation. Regardless it is clear that future work on this topic is needed to flesh out issues relevant to success. With the rapid evolution of business technologies, the need for such work in the near future is crucial.

It is furthermore the hope of the authors that the current work can serve as a guide for future research of this kind into the realm of ERP. As an immediate example, we close by suggesting a second postulation regarding the ability to move forward with ERP implementations after various B2B and alternately focused information technologies become established in-house. Consider a simple analogy. Imagine a peg-board accompanied by various pegs, none of which properly fit the holes of the board. When given the task of fitting, a decision maker is faced with

the choice of either refashioning the board to fit the various pegs, or refashioning the various pegs to fit the requirements of the board. If multiple resources are available to assist in the task, the decision maker might minimize the amount of time and effort spent by managing multiple small and well defined projects simultaneously. The choice of refashioning the pegs would provide such an opportunity, whereas the refashioning of the board might pose a more daunting task as far as resource coordination is concerned. When adopting non-infrastructural technologies, firms must consider whether or not they will be able to easily fit these various applications to an existing or future infrastructure. If these applications instead mandate the definition of a unique and non-existent infrastructure, firms need to ask themselves whether the cost of such future development can be accommodated, and perhaps more importantly, why one does not already exist. Such a realization may therefore serve as a signpost for impending disaster.

Issues such as this remain uninvestigated from an academic standpoint, but are worthy of future work. The introduction of unforeseen technologies to come will likely provide yet more interesting facets for the academic business community to pursue. One thing that is certain is the long-term nature of the ERP system concept. With well-established theory already in place, for the field of Operations Management, the research potential seems unbounded.

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