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Enterprise Resource Planning (ERP) Technology; Sales Demand, Manufacturing and Marketing Interface

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ABSTRACT

The sales demand, manufacturing and marketing (SDM&M) interface has received ample thought in the Operations Management Literature; relatively there is a need to give much more emphasis towards the awareness and thought on the important role of information systems developed as Technology called Enterprise Resource Planning (ERP) in bringing SDM&M integration on One Platform. As integrated multi cross-functional systems, are of a kind to provide SDM&M integration. Based on information dealing out theory, the aim of this paper is to examine "the bigger the interdependence between sales demand, manufacturing and marketing, the greater is the benefit of ERP. Specifically, H1 gives us that the greater ERP enabled coordination between sales demands, manufacturing and marketing, the greater the benefit of ERP to the Unit. H2 brings out that the degree to the level ERP-enabled sales demand, manufacturing and marketing bringing together improvements are found in the reality, depends on the percentage of interdependence between sales demand, manufacturing and marketing. By adopting numerous regressions, the model is based on survey details from 67 manufacturing units running ERP. The findings stand on the side of H1 and H2. These findings support the intention that interdependence between functions is one major factor that influences the degree level to which organizations bring in benefits in the form of Return on Investments (ROI) on ERP. Based on the study of ERP literature, the model controls for the time line that ERP has been running in the unit; this factor was realized not to be significant in the model. However, examining the importance of time line we finds that time line is associated with much more needed other befits from ERP.

Keywords: Enterprise Resource Planning (ERP); Sales demand, Manufacturing and Marketing (SDM&M); Interdependence; Return on Investment (ROI); integration;

1. INTRODUCTION

Aggressive competition has put business currently under pressure to be more approachable to demand for new product introductions and modifications. At the same time the demand of product environment is increasing in complexity. For example, coordination has become challenging for many business units as their operations have become increasingly distributed both geographically and organizationally across more suppliers, sales and distribution channels. Manufacturing companies can respond in a number ways (which are not mutually exclusive). One response is to increase capacity or inventory buffers (Galbraith, 1973; Newman, Hanna and Krause, 2000). However, many industries are finding that the viability of this option is decreasing. A second response is to simplify production according to the demand ration of sales and other processes (Krajewski, King, Ritzman and Wong, 1987; Huson and Nanda, 1995;

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Schroeder and Morris, 1997). A third is to increase integration between sales demand, manufacturing and marketing , which may increase the amount of information available to one work unit about conditions in other work units or in the external environment (Wheelwright and Hayes, 1985; Adler, 1995; Hauptman and Hirji, 1996).

The third option - increase in integration of SDM&M by the Companies have numerous decisions. Among the most basic of these are: which process is to integrate and how to integrate. In response to the first question, scholars have suggested that Sales Demand, Manufacturing and Marketing (SDM&M) integration always result in increase in performance-related outcomes. On reply to the second question, a majority of mid-size and Fortune 100 companies have chosen to Enterprise Resource Planning (ERP) also called as the whole business integration at one platform means increasing integration among business functions (META Group, 2004). In spite of early evidence to the contrary, ERP systems do appear to capitulate benefits to the average firm (Anderson, Banker and Ravindran, 2003). In thinking about the how and where issues, one place we might expect to see ERP deliver large payoffs is in the SDM&M interface. After all, as a multi cross-functional system, ERP should increase performance by improving coordination between sales demands, manufacturing and marketing —the functions that often have important silos under earlier transaction processing systems, such as MRP and some MRPII systems.

However, the operations management research has yet to painstakingly investigate the usefulness of ERP as a means of meeting sales demand, manufacturing and marketing integration. This paper is an effort to fill this bridge of gap using information transmitting theory. After reviewing the empirical sales demand, manufacturing and marketing interface literature, we argue that sales demand, manufacturing and marketing interdependence is an important source of uncertainty. It is suggested ERP may be effective in responding to this uncertainty by providing data on sales demand, manufacturing and marketing integration. Specifically, emphasis of the argument was the greater the interdependence between manufacturing, sales and distribution, the greater the benefit from ERP on account of sales demand and future planning of the current product and futures products. Next, we describe our test of the impact of ERP at different levels of sales demand, manufacturing and marketing interdependence. We use a survey methodology. After establishing the measurement validity of the data, we perform regression on data from 107 manufacturing units. The data support the notion that interdependence is associated with greater ERP benefits. Finally we discuss the implications of this finding as well as limitations and future research.

2. LITERATURE REVIEW

2.1 Sales demand, Manufacturing and Marketing (SDM&M) interface.

A 2002 literature review noted that, although there is great number of conceptual and rescriptive articles describing the value of the SDM&M interface. Studies on new product development (e.g. Heelwright and Clark, 1992; Adler, 1995; Hauptman and Hirji, 1996) are debatably the exception. Number of empirical papers has appeared since 2000. However, the ratio of analytical and empirical to conceptual papers is still low, suggesting the need for additional positive research. According to the findings by Sharma (2002), this need may be especially great at the tactical and operational, rather than strategic end of the decision gamut.

Nevertheless, experimental evidence suggests a relationship between SDM&M integration and performance-related outcomes. Montgomery & Roth. (2002) find that cooperation between manufacturing and marketing is related to profit performance, competitive position and morale. Sawney and Piper (2002) report that the speed and quality of the SDM&M interface positively affects defect rate, lateness and lead-time. Nahm, Vonderembse and Koufteros (2003) find that horizontal integration affects performance through its impact on time-ratio based manufacturing. Other empirical work establishes conditions of integration under which Sales & Distribution alongwith manufacturing is most and least valuable. These conditions include presence of a differentiation-integration business strategy (O'Leary-Kelly and Flores, 2002), demand uncertainty (Calantone, Droge and Vickery, 2002; O'Leary-Kelly and Flores, 2002), competitor unpredictability (Calantone et al., 2002), frequency of new product introductions and novelty of products and internal processes (Tatikonda and Montoya-Weiss, 2001).

2.1.1 Mechanisms for SDM&M integration

In addition to testing the conditions under which SDM&M integration may be valuable, the literature examines a numeral mechanisms for integrating sales demand, manufacturing and marketing for managing interface. These include imaginative relations between functions for example the degree of level to which functions have to work jointly (Hausman et al., 2002; McAfee, 2002; O'Leary-Kelly and Flores, 2002) or consult with one another (Sawhney and Piper, 2002). Lateral relations are also an main interface mechanism used in concurrent design (Tatikonda and Montoya-Weiss, 2001). Companies have also to institute integrative job positions (Germain, Droge and Daugherty, 1994), such as an employee who reports to the materials area but works full time with sales and distribution. Empirical SDMM studies have also examined committees (Germain et al., 1994) and hierarchical control (Van Dierdonck and Miller, 1980).

However, the SDMM interface literature available as on date pays less attention to information technology as an integrative system in the form of mechanism. Certainly the literature published by IT vendors, such as SAP, Microsoft, JD Adwards, PeopleSoft positions integrated IT as a way to effectively integrate production, sales and marketing. Moreover expenditures on integrated systems (including ERP, sales and distribution, marketing management, supplier relationship management, and customer relationship management) over the past 15 years have been huge. Thus it seems reasonable to investigate the effectiveness of an IT-based approach to SDMM integration—especially because the existing ERP literature raises some concerns about ERP's value in this area, as the next section discusses.

2.2 Enterprise Resource Planning (ERP) Technology

A defining characteristic of ERP is its level of cross-functional integration. The proto-typical ERP implementation, such as that described by Davenport (1998), is a single database and set of business applications. In practice, ERP implementations sometimes consist of multiple "instances" and process models (Markus, Tanis and van Fenema, 2000). Nevertheless, in terms of the number of business functions and locations linked together, ERP tends to be well-integrated, especially with respect to earlier generations of systems (Gattiker and Goodhue, 2002). As an integrated system, ERP may be well-suited for managing the interface between two business functions—e.g. the sales demand, manufacturing and marketing interface. ERP research can be divided into two broad categories:

Implementation Oriented Research investigates factors that contribute to system implementation success, and performance oriented research, which seeks to explain differences in ERP's effect on performance (Staehr et al. 2002). According to Al-Mashari, Al-Mudimigh and Zairi, 2003; Craighead and LaForge, 2003; Mabert, Soni and Venkataramanan, 2003; Muscatello, Small and Chen, 2003; Schrnederjans and Kim, 2003; Somers and Nelson, 2003; Umble, Haft and Umble, 2003; Sheu, Chae and Yang, 2004) is the more developed of the two.

Hitt et al. (2002) demonstrate that ERP adopters outperform non-adopters on productivity, financial and stock market metrics. They also show that, among adopters, performance increases when ERP is implemented. Anderson et al. (2003) find a large stock market valuation multiple from ERP investments. These studies demonstrate that the benefits of ERP systems are positive on average when we look at aggregated, business level performance.

Similarly, respondents to Stratman and Roth's (2002) improved business performance trade scale reported positive ERP improvements related to overall functional efficiency and process re-engineering; however, they reported neutral to negative ERP impacts on control of operating expenses and customer satisfaction. In a 2001 survey of APICS members, IT user groups and others, approximately 70 percent of respondents reported that their ERP systems were "successful" or "very successful," however 30 percent self-described as "neutral" or "disappointing" . A 300-day longitudinal study of a company's archival data (McAfee, 2002) found that operational performance indicators dipped at the initial stage and eventually exceeded the levels than existed levels when ERP was implemented.

Taken together, the Hitt and Anderson firm level studies coupled with the operations studies suggest an interesting challenge. The business unit level studies suggest an overall positive effect of ERP. However, the operations studies discussed above are fairly unexcited. This study found that the benefit of particular MRPII modules increased with the complexity and uncertainty of the manufacturing environment (e.g. number of suppliers, product complexity and quantum of sales). The broader implication is that one cannot discern the value of integrated IT by generalizing across a various sample of units. Rather, the value of an IT investment may depend on operating and environmental characteristics. Study finds that value of ERP varies, depending organizational structure. Similarly, literature review gives out that ERP can be configured to perform profitably under a wide diversity of conditions; ERP delivers the most to companies whose processes are centralized and relatively homogeneous.

2.3 Information and Integrating Processing Theory (IIPT)

IIPT can help us make sense of the above findings and it is a valuable lens for examining the sales demand, manufacturing and marketing interface. According to IPT the key task for organizations is managing uncertainty, such as task complexity and the rate of environmental change (Galbraith, 1973; Galbraith, 1977; Tushman and Nadler, 1978). To do so, organizations must deploy the information processing mechanism (or combination of mechanisms) that is most appropriate for managing the uncertainty (amount and type of uncertainty) that the organization faces. Galbraith (1973; 1977) suggests that simple coordination mechanisms (e.g. standard operating procedures, hierarchical referral) are appropriate for low uncertainty environments. However, as uncertainty increases, firms must respond with some combination of four more complex modes. In particular, information processing capacity can be increased by (1)

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facilitating lateral relations between sub-units, or by (2) implementing an integrated computer information system, such as ERP. The need for information processing can be reduced by (3) creating self-contained tasks or by (4) accepting greater inefficiency or "slack".

Focusing on options 1 and 2, figure 1 summarizes the theory.

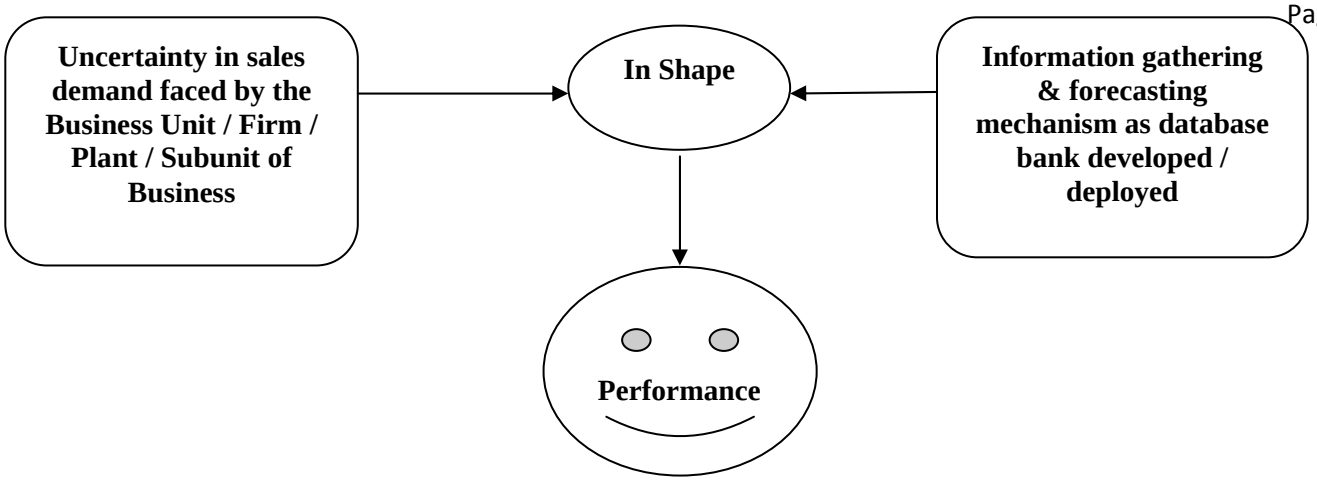

Figure 1. Overview Information and Integrating Processing Theory

Applying IIPT to manufacturing units, Flynn and Flynn (1999) examined a variety of information processing means. Their results support the theory for the most part: Improbability was associated with lesser performance, but several uncertainty management mechanisms changed tragically this relationship.

"The Greater ratio of interdependence between Sales Demand, Manufacturing and Marketing, the greater benefits from ERP".

In fact sales demand, manufacturing and marketing always share degree of interdependence, and, over the last 20 years, this interdependence has most often augmented as companies have reduced inventories and lead time buffers. Nevertheless, it is reasonable to expect the level of interdependence with sales demand, manufacturing and marketing to different from business y to business and unit to unit within a company. For example, units that produce many product configurations or that cover new markets or that have unpredictable competitors have to coordinate manufacturing and marketing decisions strongly. By contrast, a mature market for standard products may change little from day to day or month to month and thus would not require frequent re-allocations of manufacturing resources based on market conditions and demands of product. Sales demand, manufacturing and marketing interdependence associated with uncertainty is higher for the first type of plant than for the second.

3. RESEARCH METHODOLOGY / MODEL

In order to investigate the research question we developed a conceptual model (figure two). Noting that researchers have experienced difficulty detecting organization-level information

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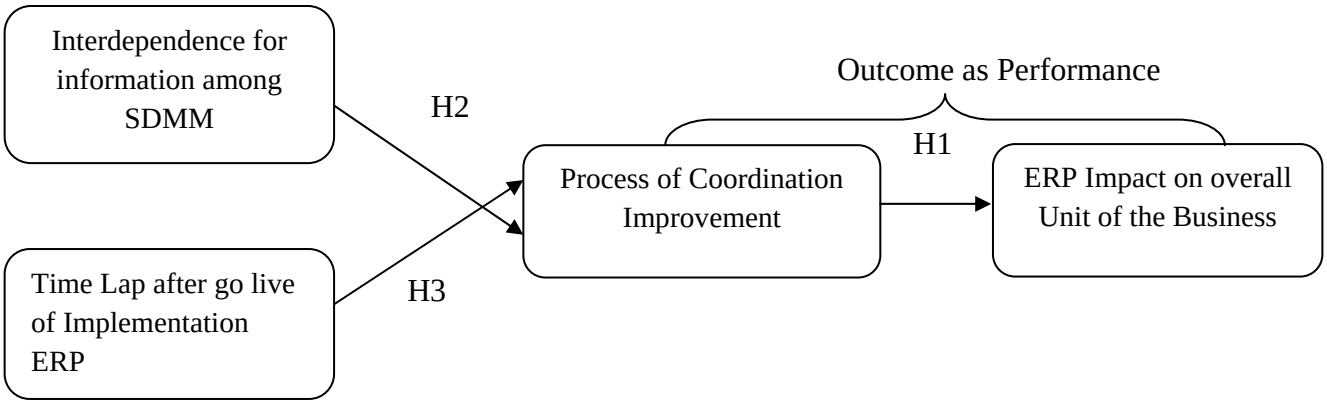
systems impacts (when they exist), One of the guidelines states recommendations is to focus at lower levels of the organization (e.g. the individual business function or business unit), rather than the entire firm. Following this advice, our ultimate dependent variable is the overall plant-level ERP impact (rather than, say, company-wide impact). This unit-level focus is consistent with a great deal of other operations management literature. A plant focus may be particularly appropriate for ERP research because ERP configurations may differ from plant to plant within a firm. Further it is relevant to mention, operations characteristics often differ substantially across the units in a firm (Skinner, 1974) potentially resulting in unit to unit varies in the impact of an ERP within the company. Capturing "intermediate variables" that may lead to the overall effect of the information system. This paper's focus on the sales demand, manufacturing and marketing integration at a one interface platform benefit to examine should be ERP-enabled SDMM coordination improvements. We define coordination improvement as the degree to which ERP helps a plant adjust to changing conditions relating to sales demand and distribution. Our model suggests that these coordination improvements are an important part of ERP's overall plant level impact. Thus our first hypothesis is:

H1: Greater ERP - enabled improvement in coordination with sales and distribution, sales demand is associated greater overall unit level ERP benefit.

Figure 2: Research model of the effect of interdependence on units running ERP



3.1 Interdependence

As an integrated system, ERP provides manufacturing with information from marketing applications. As discussed in the section 2.3, information processing theory suggests that the greater the level of interdependence between the two functions, the greater the benefit of such information. Thus:

H2: Greater sales demand, manufacturing and marketing interdependence is associated with greater ERP-enabled coordination improvement

Note that, our objective is to explain variation in results among firms who have implemented ERP. Since big companies have already installed ERP, we believe ours is a more practical objective than attempting to provide guidance on whether or not to adopt the software in the first place. Thus our model applies to units that are running ERP. If, by contrast, we were interested

in the adopt/no adopt decision, we would find a way to hold interdependence constant among firms that have and have not implemented ERP. However, since our focus is on the business units that have implemented ERP, we examine changeable levels of interdependence among a sample of firms that have all implemented ERP.

3.2 Time since implementation

Case study research has suggested that some impacts of ERP may improve with time as unforeseen problems are solved and users move up the learning curve (Markus and Tanis, 1999; Ross and Vitale, 2000; Ash and Burn, 2003). Thus time might mask or amplify any effect of the substantive variables in the research model. Thus, it is necessary to control for the effects of time elapsed, and we introduce the following control hypothesis to do so:

H3 (control hypothesis): The greater the time elapsed since ERP implementation, the greater the ERP-enabled coordination improvements

4. DATA COLLECTION

The target survey respondent was someone working in a manufacturing job. Therefore we surveyed a sample provided by APICS, as well members of user associations of two of the major ERP packages. Unfortunately, the user groups consisted mostly of IT staff but did include some operations people. Potential participants were either sent or given a paper survey and cover letter, or were given an email solicitation inviting them to visit a web site with a parallel version of the survey. IT, consultants and non-operations people were removed from the pool of surveys returned as were individuals who indicated that their plant had not implemented ERP. Further, based on our definition of ERP as a functionally integrated system, we omitted respondents representing systems that were not integrated— systems that lacked MRP, accounting and marketing functions (see table1). Surveys with missing values were also culled. This left 124 usable responses. Surveys from APICS mailing lists and APICS list serves accounted for about 80 percent of the usable responses. Computing an overall response rate is problematic because email solicitations were sent to list-serves and the composition of the list serve subscribers (practitioners, academics, consultants, manufacturing versus service, and so on) is unknown and because even a substantial number of manufacturing plant personnel in the pool were in units that had not implemented ERP. We do know that our response rate on pencil and paper surveys sent to mailing lists (which included units that had not implemented ERP) was approximately 10 percent. When sending the survey, we could not filter out units that had not implemented ERP (although we did filter out non-ERP units from the responses, as described in the preceding paragraph). Respondents in these units presumably had little motivation to fill out the survey and return it (although the survey provided a space for them to indicate that there plant had not implemented ERP). Thus, it is logical to assume that our response rate among units that had implemented ERP was much higher than our overall response rate, but we have no way of establishing this.

4.1 Sample characteristics

Case study evidence suggests that ERP impacts are normally depressing immediately after implementation but improve with time and ultimately become positive (Ross and Vitale, 2000; Ash and Burn, 2003). Larger sample research provides some confirmation of this (Cosgrove Ware, 2003). We are interested in the sustained effects of ERP, not implementation related

problems. Therefore we sought to exclude observations for which little time had elapsed to work out the inevitable implementation-related difficulties (e.g. user resistance to change, technical problems, and so on). A recent study (Cosgrove Ware, 2003) suggests that a year is sufficient time for such problems to be resolved. Therefore we excluded 17 observations representing units that had been running ERP for less than one year. This left 107 observations. The sample does not contain more than one plant per company.

The following industries were represented by at least five percent of the sample: automotive, chemicals, consumer, electronics, IT and other processing. All the companies in this sample had implemented Sales and Distribution, manufacturing and marketing and accounting modules as part of their ERP system (table 1); and the majority had shop floor and engineering modules. The size of the average implementation was six units. Tables 2 through 5 provide further information about the sample. As table 4 indicates, 18 percent of the units had implemented ERP systems that are not "big names" like SAP. Respondents did list the names of these packages/vendors the survey. We looked these up on a manufacturing software directory to ensure that they really were ERP systems.

Table 1: Modules in ERP implementation

Modules of ERP Implementation(Nos. of Plants in Business Unit running the system)	Percent of Business units running this function
Purchasing	100
Sales and Distribution	100
Accounting	100
CRM	100
Engineering	53
Human Resources	33
Shop Floor	77

Table 2: Frequency breakdown by company size (no. of employees)

Company Size	% of units in the companies of this size
1- 2000	40
2000- 10000	35
10000 +	25

Table 3: Regularity of breakdown by job function

Job Function	% of Total
Planner/Buyer/Scheduler	20
Purchasing / Materials Manager	44
Operations Manager	16
Plant/Business Unit Manager	11
Other Positions	9

Table 4: Rate of breakdown by software vendor

ERP Vendors	% of Total
SAP	37
JD Edwards	17
Oracle	7
QAD	7
PeopleSoft	5
Baan	4
Other	18
BPICS/SSA	5

Table 5: Time period since ERP implementation at plant (since "go-live")

Time Period Since ERP Implementation	% of Total
12 to 17	42
24 to 35	26
36 to 47	15
48 to 59	11
60	11
72	2

5. IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH

5.1 Implications

The sales demand, manufacturing and marketing interface has received substantial consideration in the literature; however, compared to other means of coordination, relatively little attention has been paid to the role of information systems in facilitating the SDM&M interface. This study finds that ERP's overall plant level impact is neutral to positive. More significantly, the study finds that improvements in coordination between marketing and manufacturing are an important antecedent of this overall plant-level impact. In other words, ERP's facilitate SDM&M coordination does indeed account for an important part of ERP's favorable impact on manufacturing. In fact, SDM&M coordination improvements explain 38 percent of the plant-to plant-variation in overall impact in this study.

Much of the empirical SDM&M interface literature suggests that the greater the uncertainty, the greater the value of SDM&M integration. These results extend this finding to IT-enabled SDM&M integration in particular: Interdependence among subunits is an important source of uncertainty (Tushman and Nadler, 1978). Interdependence explains approximately 25 percent of the variation in coordination improvements. There is a direct pathway from SDM&M interdependence to ERP-enabled SDM&M coordination improvements and from these coordination improvements to overall plant level ERP impact.

In response to a variety of pressures, managers need to know what to integrate and how to integrate. Statements from the IT vendors and consulting community suggest great faith in greater information systems-enabled integration yields greater business benefits. These directly improve employee and operating efficiencies and effectiveness, driving up overall corporate productivity potential for years to come. Based on this logic, more and more integration everywhere in the business might seem like a logical objective.

Indeed ERP-driven integration among business functions has had a positive effect on the average Business. However, it is also important to note (as managers are certainly aware) that results vary from company to company—and across business functions and units within companies. When ERP yields less than is expected in a plant or location, typical attributions include employee resistance to change, unrealistic promises by vendors, and so on. However, this paper suggests another explanation: Simply put, integrated information systems will not have equal payoffs under all conditions. Interdependence is one condition that appears to influence on return on investment in other words payoffs. Rather than accepting generalizations about the benefits of information technology, operations decision-makers must think logically about the pathways by which the benefits will accrue in their particular organizations.

5.2 Limitations and Future Research

The unit of analysis in this paper is the manufacturing plant. We focused on the individual plant Because of our interest in how the impacts of ERP occur. Answering this requires focusing at the operations level. In most manufacturing organizations, most operations occur in the units. The plant level impact essentially "adds up" to the company level impact. Because the manufacturing strategy (Skinner 1974) and ERP literature (Gattiker and Goodhue 2004) suggest that ERP may affect different units within a company differently due to plant specific factors (such as plant-to-plant differences in manufacturing volume, levels of customization and so on), focusing only at the firm level may obscure some variables that contribute to ERP's success or failure. Therefore, our plant-level focus—while certainly not capturing the whole picture—provides a compliment to the many excellent firm-level studies in the extant ERP literature.

The scope of this paper is fairly limited. Thus the study differs from many earlier papers (on MRP and ERP) which comprehensively examine a great number of potential antecedents to success. Although quite high already, the explained variance in this paper would no doubt be higher if a comprehensive approach were employed. However, this project's objective was to explore one theoretical construct—interdependence—with respect ERP's role in the sales demand, manufacturing and marketing interface. Because the importance of interdependence in a number of organizational theories, "going deeper rather than broader" seems justified.

This study analyzes the impact of ERP-driven cross functional integration in manufacturing from the perspective of the manufacturing plant. In other words, we cannot rule out the possibility that non-ERP-related company actions or other phenomena influenced our dependent and independent variables and thus caused us to incorrectly assess the impact of ERP.

6. CONCLUSION

The mechanisms for coordinating sales demand, marketing and manufacturing always differ from mind to mind and region to region due to geographically and other reasons. One which is currently used can be out dated according to the new challenges of the day-to-day competetition and changes in the technology are very difficult to measure in terms for success. A study that would identify the mechanisms being used as a success today and the conditions under which they were and can be more successful in different times would keeps a big value". Using Information Integration Processing Theory, this study investigates one coordination mechanism—ERP—and finds that the degree of level to the Business unit achieves benefits from the mechanism is affected by interdependence-related uncertainty. This finding is consistent with other sales and demand, manufacturing, sales and distribution interface research, which generally finds that the value of SDM&M integration is affected by uncertainty. .

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