Transaction Processing Versus Decision Support:

Understanding the Benefits from ERP

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ABSTRACT

Senior managers at over 300 manufacturing firms participated in in-depth interviews. At each firm, information was obtained about the firm's operating characteristics and the benefits obtained from several, ERP-related software applications. Benefits obtained are very different for ERP applications that process transactions as compared to applications that support decisions. The benefits derived from using transaction-processing applications are similar in most organizations, and do not depend upon each organization's operating characteristics. But the benefits derived from using applications that are decision-support-oriented vary from one organization to another, depending upon each organization's specific operational characteristics. To evaluate the potential benefit from an ERP system, and to properly plan its implementation, managers and consultants must understand the firm's operating characteristics. Developers of decision-support systems (DSS) likewise must focus on these characteristics to make sure their systems add value to the organization.

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Introduction

Enterprise Resource Planning (ERP) systems have been widely implemented but have produced mixed results. Some companies that implemented ERP systems reduced their cycle time, improved their financial management, and obtained information faster (Davenport, 2000). Others companies found that ERP systems are costly to purchase and implement, and that they sometimes fail entirely or produce only a fraction of the expected benefits. The *New York Times* ran an article on "Software That Can Make A Grown Company Cry," describing some troubled ERP implementations (Deutsch, 1998). Allied Waste Industries, for example, purchased an ERP software package from SAP America, a major ERP software vendor, but discontinued its use after finding it too complicated, too expensive, and a poor value in terms of added functionality (Bailey, 1999). Allied Waste lost over $40 million on this project.

These days, senior IT executives recognize that new systems must deliver added value. John Crary, Vice President for Information Technology of Lear Corporation (the fourth-largest automotive supplier worldwide with $13.6 billion annual sales), said that Lear does not invest in IT just to use the latest and greatest technology. They have to go through a justification process for every new IT project, even if the payoff is clear. They must prove that there will be added value to the company.[1] Mr. Crary's comments were echoed a year later at the same conference by Betty Walker and Susan Kampe, the IT VPs and CIOs of Delphi Corporation and Johnson

[1] Presentation made at AUTOe, the Information Technology for the Automotive Industry conference, Troy, Michigan April 2003.

Controls, Inc. respectively.[2] Similarly, Perry Lipe, Senior Vice President and CIO of ArvinMeritor, (an automotive supplier with $7 billion annual sales) states that his company will make an investment in IT only if it clearly adds value to the organization.[3] IT managers in companies of all sizes – not just the "Fortune 500" – need methods for estimating the benefits and the value that will be obtained from using a new ERP package or application.

The purpose of this paper is to help managers and systems developers identify the value ERP systems and applications may add to their organizations, and determine under what circumstances this added value will be obtained. For developers of decision support systems (DSS), this paper offers insights into ways to "make the case" for such systems and what data may be most important to include in these systems. The results presented in this study are based on in-depth interviews with senior managers at over 300 manufacturing firms. Although our research focuses on manufacturers, the results are likely to apply as well to other organizations that use ERP.

We begin by summarizing the nature of ERP systems and their potential benefits. Then, we examine the two broad uses of these software packages, transaction processing and management decision support. Next, we describe the linkages between benefits from ERP and a company's organizational characteristics. Finally, we offer recommendations for how managers and systems developers can identify appropriate ERP and DSS applications and use them effectively.

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[2] Presentations made at AUTOe, the Information Technology for the Automotive Industry conference, Troy, Michigan April 2004. Delphi and Johnson Controls are respectively the largest and the third-largest automotive suppliers world-wide.

[3] Presentation at Oakland University's Fifth Fall Conference on Managing Information Technologies, Oakland University, October 11-12, 2002.

ERP - Concepts and Potential Benefits

ERP systems help organizations manage their supply chain, receiving, inventories, customer orders, production planning, shipping, accounting, human resources, and all other activities that take place in a modern business. Amoako-Gyampah and Salam (2004) argue that the complexity of ERP systems distinguish them from other simpler technology implementations. In short, ERP is a strategic business solution that integrates all the business functions.

The first task of an ERP system is to collect the data that are generated throughout the organization, validate them, and store them in a central database that all authorized users can access to produce accurate, timely, and relevant information for their needs (Falk, 2005). Having a common database means entering data only once, thus minimizing data-entry errors. Building the database forces managers in various departments to agree on common definitions for, and responsibilities for entering and maintaining, pieces of data. A database that is common to all the business functions helps to integrate those functions. When, for example, a salesperson reports a customer's order, all other organizational functions that may be involved with the order (raw materials purchasing, production scheduling, shipping, and others) will be made aware of it and will be able to react appropriately. (Ragowsky and Somers, 2002; Umble and Umble, 2002).

Transaction processing versus decision support

From the common database, the ERP system generates transaction documents such as sales invoices, receiving reports, and shippers. Additionally, the ERP system produces reports that summarize the results of transaction processing, such as a daily sales summary or a financial statement. All these activities are part of the transaction processing systems (TPS) that collect and verify data, update the database, and generate reports and documents. Structured decision systems (SDS) are similar to TPS except that SDS actually make routine decisions according to

algorithms, such as automatically generating purchase orders based on predetermined reorder points. Together, TPS and SDS form the routine, repetitive, clerical part of ERP.

By their very nature, these routine transactions are essential to the on-going operation of the firm. Moreover, a computerized system can handle large transactions volumes accurately and quickly. Accordingly, the benefit derived from transaction processing systems can be quite large. Still, because these systems are readily available to most firms, TPS (and, to a slightly lesser extent, SDS) applications are unlikely to confer a *differential* or *strategic* benefit. However, by using its ERP system to support *management decision-making*, a firm can capitalize on its unique characteristics and thus achieve a strategic advantage.

Decision support systems (DSS) are applications that use the data stored in the central database for providing information to users to support their decision making. These users can retrieve the specific information needed for decision making, possibly add more information, and conduct "what-if" analyses to evaluate different alternatives. An example here is changing the production schedule in a small manufacturing company that makes plastic parts that are sold directly to the large automobile manufacturers. (This company and others discussed later are actual firms for which the authors provided help in planning or implementing IS applications.) Often, a customer will place a "rush" order, and the person who schedules production must find a way to squeeze in the new order, without incurring an unacceptable delay in other customer orders. In the past, the scheduler would move colored magnetic tiles around on a board on the wall of his office, trying alternative schedules to see how the rush order could be accommodated. Each colored tile represented a single job, and the board was essentially a large calendar. Top management was concerned that jobs were not being scheduled in an optimal fashion and that this manual system would not suffice as the company grew. Accordingly, a decision support

system that would facilitate production scheduling was a key need in this company's search for suitable ERP software.

Evaluating DSS Applications

To assess the potential contribution of ERP decision-support applications, one must estimate two amounts: *how much* information the decision-maker really needs to make a specific decision, and the *value* of additional information. The more uncertain/complex a specific managerial activity is, the greater is the amount of information needed by the decision-maker (Shannon, 1949). The decision maker needs timely and relevant information regarding each possible future event in order to make a good decision. When there are many possible events, the level of uncertainty is higher, the decision-making task becomes more complex, and therefore more information is needed. Indeed, Daft and Lengel argue that "one of the basic reasons organizations process information is to reduce uncertainty (Daft and Lengel, 1986). The right information reduces task complexity (Benbasat and Taylor, 1982). Ghani (1992) suggests that "the information processing view of organizations is that organizational effectiveness is a function of the fit between task uncertainty and the information processing capacity of the organization."

Although the relationship between added information and reduction of uncertainty/complexity is positive (Morell and Fleischer, 1988), merely adding more information does not necessarily increase the value of the information (Ahituv and Ronen, 1988). Instead, the value of the information relates to the impact of the decision on reaching the organization's objectives, such as increasing the organization's profitability (Strassmann, 1990; Kauffman and Mukhopadhyay, 1993). An activity can involve a high degree of uncertainty/complexity, but still have a low impact on the organization's objectives. Thus, reducing the level of uncertainty/complexity should not be the only determining factor in evaluating a new computerized

IS application. The review must also weigh the relative importance of the decisions supported by the application toward meeting the organization's objectives. Accordingly, we argue that the contribution of ERP decision-support applications is different for each organization and depends on the organizations' specific operating characteristics related to the level of uncertainty/complexity and the impact of the decision on the organization's objectives.

The role of organizational characteristics

Organizational operating characteristics were found to impact the performance of manufacturing companies (Bartezzagho & Francesco, 1989). Operating characteristics deal with issues raised earlier and others such as the average number of days to complete a work order, the lead time for raw materials, the percentage of production for customers' orders (as opposed to producing for stock). Our research identifies specific linkages between these organizational operating characteristics and the benefit a firm gets from a particular ERP application. For example, the higher the percentage of production for customers' orders, the more benefit the organization will gain from using a DSS application to support customer order management. (Ragowsky, Stern and Adams, 2000; Ragowsky and Stern, 1997). The same organizational characteristics have a significant impact on the value ERP applications can add to Porter's primary activities (Ragowsky, Somers, and Adams, 2005).

An example of the importance of studying organizational characteristics is provided by a company that manufacturers soaps and shampoo. This company has up to thirty possible suppliers of most raw materials. Each supplier has a different price, lead time, and quantity discount. The purchasing manger must carefully plan each purchase order to shorten the time raw materials will be stored in the warehouse, as a function of the requirements (based on customer orders and the production plan), availability (what is already on hand), and the

supplier's lead time. On the other hand, the purchasing manager has to check the quantity discounts and determine whether the quantity discount for ordering a quantity larger than that needed to satisfy current needs will outweigh the inventory holding costs. The large number of suppliers and the differences among them represent the level of uncertainty/complexity involved with the purchase manager's decision. Additionally, in this firm, raw materials comprise 60% of the production costs: purchasing decisions have a strong impact on the organization's profitability. The company's consultant estimated that using a DSS for the purchasing activity would lower product costs by 9% (a 15% reduction in the raw materials costs that account for 60% of total product costs). The president of the company, in fact, reports significant savings in materials costs, leading to savings in the product costs and higher profitability.

A major supplier of automotive seating systems provides another striking illustration of a decision that is both complex and important to the plant's overall performance. This plant is constrained by union contracts governing how they use hourly employees. Senior employees can select the shift and work station they prefer, and they have priority when overtime work is available. Variables representing uncertainty/complexity are the hours of work needed at each work station, the availability of employees who have the requisite skills and training for each work station, employee seniority, and the employees' preferences for shift and work station. These staffing decisions are crucial because labor costs are 10-20% of total product costs and because the plant must deliver the *required* seats to the automobile manufacturer's assembly plant on a just-in-time basis. Each seat must be delivered to the assembly plant in the exact sequence in which automobiles will be assembled. Furthermore, each seat must match the requirements of a specific automobile: style, color, materials, and features. Should the supplier plant be late, deliver the wrong seats, or deliver seats out of sequence, a high penalty (up to hundreds thousands of dollars) will be charged

to the plant. The labor cost and the potential penalty represent the importance of the decision and its impact on the organization's profit.

Both of these examples describe decisions that involve much uncertain/complexity and are also very important to the firm's performance. But consider the case of a software selection project for a company that assembles tanker-trailers. The firm's customers provide most parts for the tanker-trailers, and the firm purchases only inexpensive items such as fasteners. The purchasing agent wanted to implement a DSS application to help reduce the cost of raw materials, because he heard from customers (who purchase most of the materials – steel sheets, axles, wheels, frames, and more) how they used IS to reduce raw materials costs. But reducing the cost of incidental purchased items would only marginally improve profits. Since raw materials represent only 5% of production costs in this company, even if a 15% reduction were obtained in materials costs, overall product costs would drop by only 0.75% (15% of 5%). Although the purchasing decision was involved a high level of complexity and uncertainty, it was not of crucial importance to the performance of the firm. Accordingly, the purchasing DSS was not included as a need in the RFP sent to software vendors.

Transaction processing and decision support: a key to understanding benefits from ERP

Research paints a mixed picture of the benefits companies obtain from using ERP packages. On one hand, some studies (e.g., Johansen et. al, 1995) argue that one of the benefits of these systems is that they help coordinate the multitude of tasks in the manufacturing environment. On the other hand, there is a body of literature suggesting that managers do not perceive strong benefits from the use of ERP (see, in particular, Gupta, 1994).

To help understand these conflicting research results, we must distinguish between transaction-processing and decision-support applications. TPS (and SDS) process routine transactions, and are essential to the basic operation of all companies. Many companies can

process routine transactions in much the same way, and transaction-processing requirements are usually well understood and similar in many companies. On the other hand, DSS support making decisions that relate to each firm's particular circumstances. The impact of a specific decision on organizational performance may differ greatly from one company to another. Merely describing these decisions can be difficult, and specifying what information is needed to make them can be harder still. A given DSS application may or may not benefit an organization, depending on that organization's unique characteristics, as illustrated by the examples presented above.

Our study examined most applications commonly included in ERP software packages. We classified each ERP-related application as being transaction processing, structured decision, or decision support. From a list of over four thousand manufacturing firms, companies were group by manufacturing sector, and within each sector a sample of firms was randomly selected. At each company, we collected data by conducting a structured, in-depth, and in-person interview with a senior manager (usually the president or a vice president). The interviewer recorded the manager's responses on a detailed questionnaire. The questions in the survey were divided into two sections. The first section covered organizational characteristics (e.g., number of suppliers, proportion of raw materials cost in the total cost of the final product, average sales lead time to customers, number of production lines, complexity of bills of materials). In the second section, the interviewees were asked to rank the benefit their organization gained from using each ERP application. The scale ranged from 1 (low benefit) to 7 (high benefit). Using an interviewee's perception on such a scale as a proxy for the real benefit has been frequently used and justified in the IT literature (Tallon et. Al, 2000)**.** We analyzed the survey data by stepwise multiple linear regression. The dependent variables were the benefits the managers perceived their organizations to derive from using each of the applications. The independent variables were the organizational characteristics. For instance, as shown in Table 3 (parts a and b), the regression for "Customer

Order Management" shows that the benefit from this application depends upon the number of days to complete a work order, the percentage of production that fulfills specific customer orders, the average lead time for raw materials, and whether vendors offer quantity discounts.

Findings

Tables 1 and 2 describe the distribution of the sample based on different organizational characteristics, and the firm's industry. As can be seen, the companies sampled are diverse in size, industry, and type of manufacturing process. The variables representing the organizational characteristics are listed in Table 3a with a description for each variable. The results of the regression analysis are summarized in Table 3b. The last three lines of that table 3b present the type of application, the average benefit on a seven-point scale, and the coefficient of determination (R-Square). R-Square can be interpreted as the proportion (from 0 to 1) of the benefit derived from each application that is explained by the organizational characteristics, or how "accurately" the organizational characteristics can predict the benefit an organization will derive from using an individual ERP application. Figure 1 graphs the average R-square values for each type of application. The cells in Table 3b with plus or minus signs show which organizational characteristics have a statistically significant ($p < .05$) positive/negative linkage to the benefits obtained from each IS application; these results will be discussed later.

The bottom three lines of Table 3b show that while transaction-oriented applications were seen as highly beneficial to the organization, decision-support applications were seen as less so. This finding must be inspected more closely to avoid a mistaken impression about the value of DSS. TPS and SDS comprise the routine and repetitive part of the ERP system, and applications such as bookkeeping and inventory management are *essential* to the operation of any manufacturing firm, regardless of its organizational characteristics. Hence, all companies gain

similarly-high benefits from using these applications. Consequently, the average benefit for these applications is high, with little variation in benefit among different organizations. The benefit derived from using DSS applications, on the other hand, is different for different organizations. For any specific DSS application, some organizations may gain much benefit, while others may gain little if any benefit, depending on each firm's organizational characteristics. Hence, the *average* benefit across the entire sample is lower than for TPS, with higher variation in the benefits among different organizations.

Table 3b and Figure 1 both show that the benefits derived from using the ERP applications depend upon organizational characteristics. Importantly, the more the application is oriented toward supporting unstructured decisions, the higher the R-Square value. For the project management DSS application, the organizational characteristics explain about 52% (which is quite high) of the variance in the benefit (the dependent variable). For the Bookkeeping application the organizational characteristics do not explain any of the variance in the benefit. For the other two TPS applications (inventory management and quality control), the organizational characteristics explain a small portion of the variance (8.99% and 3.21% respectively). For the SDS applications the organizational characteristics explain a little more of the variance, but it is still low (16.01% and 18.68%). The machine maintenance application is a combination of SDS and DSS. The R-Square value for this application is a little higher (25.31%), but still lower than for DSS applications. For the DSS applications (suppliers and purchasing, customer order management, and project management), the R-Square value is higher (39.5%, 40.19%, and 51.68% respectively). These findings suggest that the more decision-making is involved in an ERP application, the tighter the linkage between the benefit from using the application and the organizational characteristics.

Table 3b shows which organizational characteristics had a significant linkage with the benefit obtained from each IS application. A plus sign indicates that the benefit from the application rises as the numerical value of the organizational characteristic increases; a minus sign denotes an inverse relationship. No characteristic was linked to the benefit derived from "bookkeeping" applications, most likely because these applications are essential to the operations of all manufacturing firms, regardless of their specific characteristics.

The "Suppliers and Purchasing" application is positively related to the percentage that raw materials cost represents in total product cost, the percentage that planning and design cost represents in total product cost, and the lead time from suppliers. The greater the percentage of total product cost that raw materials represent, the more impact purchase cost reductions will have on the firm's profits. When planning and design costs are large, there often is extensive consultation with suppliers regarding specifications and costs for raw materials and sub-components. The longer the lead time, the higher the possibility that needs for raw materials will be changed. Hence, more information is needed to manage the purchase orders (Ragowsky, Stern, and Adams, 2000). As mentioned above, the company that produces shampoo and soap gain a significant benefit from using a DSS application to help manage purchases. The cost of the raw materials compared to the total cost of the product was high (60%); they had many suppliers, with many differences among the suppliers.

The benefit from the "Customers Order Management" application *increases* when the average number of days to complete a work order *decreases.* A possible explanation is that many firms with long production times have only a few jobs in process at any given time, making it easy to track the status of a customer's order. (In these cases, the products may be very complicated, and the project management application may help track the order's progress as discussed below.) As expected, the benefit from this application rises when the percentage of

production for specific orders increases. When producing for inventory, there is no need for this application. The benefit from the "Customers" application also rises with increases in the lead time for raw materials and when suppliers' prices for raw materials are flexible, depending on the quantities ordered. A possible explanation for these linkages is that, to minimize inventory holding costs, a company will try to purchase raw materials as close as possible to when they are needed. But if vendors offer quantity discounts, the purchasing manager must balance purchase price against holding costs, purchasing and storing more materials in order to obtain the best prices. As the lead time for obtaining raw materials lengthens, it becomes increasingly difficult to plan purchases and more information is needed about the timing of customer orders. A company that faces such a scenario is the manufacturer of electrical outlets and switches for the building industry mentioned earlier. This company sells to construction contractors as opposed to consumers. The products are specialized with different sizes, colors, and styles. Each combination of size, color, and style has its own part number. The constructors place purchase orders based on the predicted progress of the construction. However, based on actual construction progress, a constructor may change the requested shipping dates of the products. The company schedules its production based on the customers' orders and the scheduled shipping dates (adjusted by the changes just mentioned). In order to plan production and the purchase of raw materials, the company implemented both the customer order and the purchasing applications. The president of the company reported more timely delivery to the customers and reductions in the cost of both raw materials and finished goods inventory. Based on information from the customers' orders, the company also was able to better plan the production schedule and make more efficient use of production resources (machinery and labor).

The benefit from the Project Management application depends upon the Plant Type, Number of Days to Complete a Work Order, Number of Finished Goods, and Days Lead Time

from Suppliers. The benefit from Project Management is inversely related to "Factory Overhead as a Percentage of Total Sales Revenue." Space limitations preclude discussion of possible reasons for these relationships in this paper.

Table 3b clearly demonstrates that difference characteristics are associated with the benefits obtained from different applications. As can be seen in Table 3b, some organizational characteristics were found to have significant linkages to the benefits obtained from the inventory management and quality control applications, which are TPS applications. However, the R-square values for these applications are low. Hence, the benefit different organizations gain by using these applications does not depend upon the organizational characteristics.

Implications for Managers and Developers

Many companies that feel they have not received a significant return on their investment in ERP may be the victims of an illusion. They may have assumed that since routine and repetitive activities can be handled by standardized software, all other activities can be standardized as well. Some software vendors, and some consulting companies, foster this illusion. To promote their sales, some software vendors claim that most manufacturing companies have very similar information needs, and hence the vendor's software package is suitable for every organization. Kevin McKay, president of SAP America, said that "enterprise software can connect and automate all the basic parts of a company: sales, payments coming in and going out, inventory, and all other sorts of accounting function."[4] Sometimes software vendors try to force companies to change the way they operate to fit the software. Mr. McKay argues that the software is a business improvement device: fitting the business to the software will improve the business.

[4]As quoted in the *Wall Street Journal,* June 9, 1999.

In actuality, routine data-processing activities in most companies can be standardized effectively and efficiently (and therefore profitably for the software maker, reseller, and consultant). Yet, for management decision support, different companies need different information, and a similar application will provide different benefits to different organizations based on each organization's characteristics. Consequently, the benefit different organizations will gain by using ERP systems for decision-related purposes may vary.

To obtain full value, a company must use its ERP system to provide relevant and timely information to key decision-makers throughout the organization. Better information will lead to better decisions, and some of these decisions (as indicated by the organizational characteristics mentioned above) may support the organization's performance very significantly. The benefits from using DSS applications differs among firms, based on their organizational characteristics. Accordingly, a firm may be able to differentiate itself from its competitors and gain competitive advantage, by using those DSS applications that best fit its organizational characteristics related to uncertainty/complexity and the contribution to the firm's performance. The team conducting the needs analysis should identify the decisions that managers make. For each decision, a score should be assigned to the decision's uncertainty/complexity and the impact it has on the firm's overall profits. For those decisions with both high uncertainty/complexity and high impact, the information needed to support the decision should be identified, and a DSS application should be developed and implemented.

Increasingly, senior IT executives recognize the need to base decisions about new systems and applications on the added value provided to the organization. The approach presented in this article provides a way to identify which DSS applications do indeed add value, based on organizational characteristics. ERP packages are not "one size fits all" software. While a package's transaction-processing components may work well in a variety of companies, the

decision-support components will deliver large benefits only if they closely match an organization's specific operating characteristics.

Table 1: Distribution of the Respondent Organizations' Characteristics

	Min.	Max.	Median	Mean	St. Dev.
Annual sale volume	$1	$ 400	$33	$41.78	$39.52
Number of employees	10	2400	100	200	321
Number of suppliers	1	5000	45	177	526
Relative share of raw materials in the cost of the final product	2%	85%	44%	43.65%	15.31%
Number of customers	1	10,000	150	672	1746
Average lead time to customers (in days)	1	720	15	39	73.91

Table 2: Distribution of companies by industry

Industry	**Number of Plants**
Wood	**13**
Metal	**67**
Food	**45**
Textile	**28**
Rubber	**32**
Chemical	**30**
Paper	**19**
Electronic	**56**
Construction	**14**
Other	**6**

Figure 1 – R-square from the regression analysis

(Because it has elements of both SDS and DSS, the "Machine Maintenance" application is not included in this diagram.)

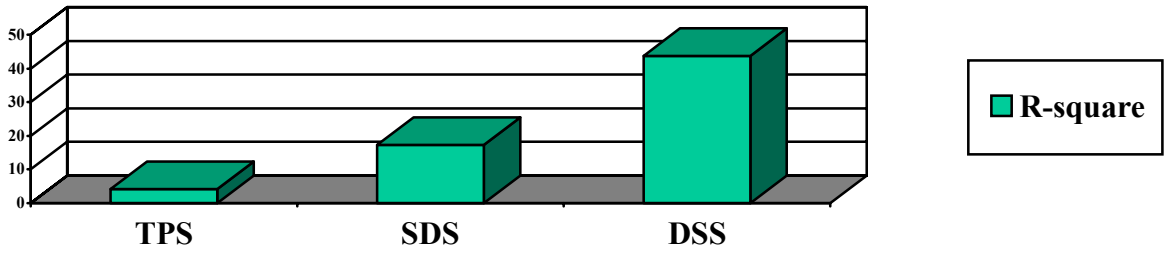

Table 3a: The Organizational Characteristics

Organizational Characteristics	
N-of App	Number of applications implemented
Plant-T	**Plant type: process, assembly, or job shop**
Prod-T	Production type: process-oriented or project-oriented
Prod-Line	Number of production lines or departments
Var-Lin	Can one line make parts for another?
Machine	Is production machine-intensive?
Var-Mac	Can one machine produce parts for another machine?
Work-day	**Average number of days to complete a work order**
Scrap	**Percentage of production that must be redone or scrapped**
Parallel	Must two or more production lines be coordinated?
Inter-It	Average number of part numbers for intermediate items
Finished	**Average number of part numbers for finished goods**
BOM	**Average number of levels in bill of materials**
Plan-%	**Percentage of total product cost represented by design and engineering**
Material-%	**Percentage of total product cost represented by raw materials**
Labor-%	Percentage of total product cost represented by direct labor costs
Machine-%	Percentage of total product cost represented by machinery costs
Sales-%	**Percentage of total product cost represented by sales costs**
Overhead-%	**Percentage of total product cost represented by overhead**
Service-%	**Percentage of total product cost represented by service after the sale**
Pro-CUS-%	**Percentage of production for specific customer orders rather than for stock**
T-Supp	**Average days lead time for raw materials**
Supp-Diff	**Do suppliers differ in lead times, price, and quality?**
Pri-Flex	**Are raw materials prices flexible depending on the quantities ordered?**

The organizational characteristics shown in **boldface** above were significantly related to the benefits obtained from one or more IS applications. For readability, only these "significant" characteristics appear in Table 3b.

Table 3b: Which characteristics impact the benefit from each application?

				IS Applications					
							Suppliers	Customer	
Organizational	Book-	Inventory	Quality	Bill of		Machine	and Pur-	Order	Project
Characteristics	keeping	Mgt.	Control	Materials	MRP	Maint.	chasing	Mgt.	Mgt.
Plant-T									+
Work-day								-	+
Scrap		-							
Finished		+				+			+
BOM				+	+				
Plan-%							+		
Material-%					+		+		
Sales-%			-						
Overhead-%									-
Service-%						-			
Pro-CUS-%								+	
T-Supp							+	+	+
Supp-Diff					+				
Pri-Flex		+		+				+	
==========	=======								
Type of Application	TPS	TPS	TPS	SDS	SDS	SDS/DSS	DSS	DSS	DSS
R-Square	0	8.99	3.21	16.01	18.68	25.31	39.65	40.19	51.68
Average Benefit	6.85	6.27	6.06	6.05	5.49	5.00	5.26	5.91	4.52
Standard Deviation	0.41	0.92	1.16	1.72	1.24	1.52	1.42	1.36	1.84

Key:

+ means the *organizational characteristic* in this row is positively related to the benefits from the *IS application* in this column.

- means the *organizational characteristic* in this row is inversely related to the benefits from the *IS application* in this column.

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