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AN EMPIRICAL ANALYSIS OF
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Julia Smith David

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Ph.D. degree in Accounting

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**AN EMPIRICAL ANALYSIS OF REA ACCOUNTING SYSTEMS,
PRODUCTIVITY, AND PERCEPTIONS OF COMPETITIVE ADVANTAGE**

By

Julia Smith David

A DISSERTATION

**Submitted to
Michigan State University
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ABSTRACT

AN EMPIRICAL ANALYSIS OF REA ACCOUNTING SYSTEMS, PRODUCTIVITY, AND PERCEPTIONS OF COMPETITIVE ADVANTAGE

By

Julia Smith David

Weakness have been identified with traditional debit/credit accounting information systems. In response to these, McCarthy (1982) developed the theory of REA accounting systems that include detailed information about economic resources, events, and agents. While several directed REA implementations have been described in the literature, no empirical analysis has been performed to determine whether REA systems provide benefits to the organizations using them. This dissertation, therefore, presents the first empirical analysis of productivity and competitive advantage improvements from REA systems.

To analyze systems currently operating in organizations, an *Accounting System Characteristics (ASC)* metric was developed which is used to place organization's systems on a continuum between traditional and REA accounting information systems. In addition, a questionnaire was developed to collect executive's perceptions of *Competitive Advantage* from their information system. This questionnaire relied heavily on the theoretical model of *Competitive Advantage* proposed by Bakos and Treacy (1986).

These metrics were used during site visits to eight companies in the pulp and paper industry. Executives of key functional areas completed the questionnaire of *Competitive Advantage* during a preliminary meeting with the researcher. This meeting was followed by two days of interviews with both executives and staff members throughout the

organizations. Each interview was structured using the *ASC* metric so that identical information would be collected from each participant.

Hypothesis testing was performed after the completion of all eight site visits. The results provide evidence that the more sophisticated systems are providing firms with administrative efficiencies, although they are not supporting interorganizational strategies for competitive advantage. In addition, firms with more sophisticated systems are more productive than those that use more traditional systems.

The major contribution of this work is that it provides a method for future researchers to compare operational systems. Key systems characteristics are identified, and the *ASC* metric provides a method of capturing information about these characteristics. As a result, more detailed hypotheses may be posed, and evidence can be gathered to evaluate the benefits that accounting systems provide to firms using them.

Bakos, J.Y. and M. E. Treacy. "Information Technology and Corporate Strategy: A Research Perspective." *MIS Quarterly* 10:2 (June 1986) pp. 107-119.

McCarthy, W.E. "The REA Accounting Model: A Generalized Framework for Accounting Systems in a Shared Data Environment." *The Accounting Review* (July 1982) pp. 554-77.

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JULIA SMITH DAVID

1995

DEDICATION

to

Scott A. David,

whose love and support made this possible

and

Jay Wilson Dorff, IV,

who didn't get the chance to finish his

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I would first like to thank the members of my committee for their time, insights, and enthusiasm. Dr. William E. McCarthy has been a mentor since 1983 when I enjoyed his undergraduate class and became fascinated with Accounting Information Systems. Dr. Severin Grabski has been instrumental in my doctoral program, encouraging me to participate in research from my first semester. Dr. Frank Boster has been a wonderful statistical reference, working with me to understand the implications of the methods used in this study. Dr. William Punch has provided a computer science perspective to this study, challenging me to consider the complex nature of the problem being studied.

I would also like to recognize each of the companies that participated in this study, and to thank all of the contact people who scheduled my visits. However, to maintain confidentiality, I am limited to saying that these people know who they are and that I appreciate all of the time they gave to make this project a success. I am looking forward to working with many in the future. In addition, I am able to acknowledge the help of Mr. Randy Johnson who was not only willing to listen to problems I experienced, but also performed a “match maker” role, identifying potential companies and making introductions. Without his influence, I would have been much less likely to have found willing participants.

Elizabeth Connors and Tami Kuhn read of earlier drafts, and made insightful, critical comments, challenging me to be more careful and specific in the text. In addition, Greg Gerard was very helpful with the factor analysis and path analysis portions of this document. Throughout my doctoral program the dinner group shared their insights into how to best succeed in the doctoral program; I am sure that we will all continue to remain true friends having shared so much while here. To all, many heartfelt thanks.

The Department of Accounting has supported this research both financially and by being flexible in my work schedule. Thank you for keeping this a four year program.

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And most importantly, I must thank my husband, Scott, for his patience, love, and support. When I questioned whether the doctoral program was the correct place for me, he was able to stay focused on the goal at the end, and he reminded me that the destination was worth the trip. Without him, I am sure I never would have made it this far.

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Chapter 1 - Introduction

Computerized accounting systems have become standard features in modern businesses, but it has been difficult to measure their impact on organizations. Much has been written about the "productivity paradox" of increased computer spending coupled with decreasing productivity in white collar workers (Roach 1991; Brynjolfsson 1993). Other research has focused on whether investing in computers provides organizations with competitive advantage (Porter 1985; Johnston and Carrico 1988; Johnston and Vitale 1988; Glazer 1993). Overall, results of these studies have been mixed.

If computer systems actually provide benefits to organizations, a possible explanation for the negative results is that not all computer systems provide productivity or competitive advantage improvements that can be measured empirically. Rather, only computer systems with certain characteristics could provide measurable benefits. This dissertation is the first empirical analysis to compare the effects of traditionally designed accounting systems and accounting systems that have been designed to reflect the business processes, specifically systems that model resources, events, and agents (REA systems). The major hypotheses are that REA systems can assist managers in improving both their productivity and their organization's position in the market. Firms using more traditional accounting systems that were designed to automate bookkeeping processes will report significantly less, if any, improvements in productivity or perceptions of competitive advantage compared to those using REA systems.

A field study approach incorporating personally-distributed surveys was used to obtain in-depth information about eight organizations. Prior to visiting the organizations, management provided financial and operational information about their organizations that

could be used to measure productivity and market position. During the site visits, executives and staff members from several functional areas completed surveys that measured their perceptions of their firm's competitive advantage and how their computer system helped provide any advantage. Each of these people was interviewed individually to gather detailed information about what procedures they performed, where the information they needed to perform these procedures was stored, and how their information system provided productivity improvements. The firm's computer system characteristics were subsequently scored along a continuum between a traditional accounting information system and an REA accounting information system.

Two different types of analysis were performed with the data gathered from the site visits. First, correlations between system characteristics, productivity levels, and perceptions of competitive advantage were identified to test the main hypotheses of this study. Second, qualitative data from the visits were used to provide a more detailed operational definition of REA accounting information systems and to summarize the key systems characteristics that provided benefits to the organizations participating in this study.

This study makes several contributions to the REA accounting systems literature. First, a metric has been developed that can be used to evaluate existing systems. It identifies systems that are more similar to REA and those more like traditional systems. In addition, it has been used to effectively communicate REA concepts to firm management, and to provide them with a concise view of their organization and its system.

Second, the qualitative results provide an operational definition of REA systems that can be used in future research. While most of the work in this area has focused on

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theoretical characteristics of these systems, the key systems characteristics described in Chapter 5 provide researchers a technique to differentiate firms between the traditional and REA extremes. They can also be used to develop more specific hypotheses about the benefits of REA systems.

Third, the quantitative results are some of the first empirical data regarding the benefits that may arise from REA systems implementations. These results support a modified version of the Bakos and Treacy (1986) model of competitive advantage that theorizes that information technology can provide competitive advantage if it either improves administrative efficiencies or implements interorganizational strategies. In addition, path analysis shows that the systems more like REA systems are perceived to improve administrative efficiencies. However, the REA systems were not found to be assisting with the interorganizational strategies.

Limited evidence is provided that REA systems are correlated with improved productivity and efficiency. Specifically, there is a significant correlation between the more advanced systems and productivity measured as sales per employee hour. In addition, these systems are significantly correlated with improved efficiency in accounts payables processing.

The remainder of this dissertation is organized as follows. Chapter two describes REA accounting systems and highlights the differences between them and more traditional accounting systems. Chapter three develops the hypotheses, while chapter four discusses the methodology to be used and the development of the metrics used to test the hypotheses. Chapter five summarizes the data analysis, and chapter six concludes with the study's contributions and suggestions for future research.

Chapter 2 - Theoretical Foundations of REA Accounting Information Systems

2.1 Traditional Accounting

Traditional accounting has roots dating to approximately 1250-1400 (Kee 1993).

Luca Pacioli is credited with writing the first manuscript describing the double-entry accounting system in 1494. He outlined concepts and processes that could be used to manage small merchant ventures when the only tools available for record keeping were paper and pens. He developed the ideas of the chart of accounts, ledgers and journals, and double-sided entries for the journals. He also showed how the ledgers could be used to help insure arithmetically correct figures, prevent fraud, and document the organization's transactions. His techniques were so successful that they have continued to be used through the 20th century.

The first step in using these traditional accounting methods is to establish a categorization structure called a chart of accounts. Each account represents an asset, liability, equity, income, or expense amount and is assigned a unique account number. These are listed in a general ledger that is used to record and report summary balances for each account. Each transaction can then be described by a journal entry that changes the levels of two or more accounts. However, to limit the number of entries to the general ledger, the accountant may first record a transaction in a subsidiary ledger that is a listing of all transactions of one type. Periodically, these detailed listings are summarized, and one journal entry is entered into the general ledger. Then the general ledger accounts and balances can be used to prepare the financial statements. The income statement uses the income and expense accounts to provide management with a financial report of how the

organization's financial position changed over a period of time. The balance sheet shows the firm's assets, liabilities and equities at a specific point in time.

The following is an example of how a sales transaction would be recorded using these traditional accounting techniques. First, the sale is recorded in a sales ledger. At the end of a batch process called invoicing, summary sales totals are calculated from the sales ledger and are entered into the general ledger. If the chart of accounts has account numbers for sales summarized by company, division, and warehouse, the following journal entry may be recorded at the end of the invoice process:

9/22	1-10-00-01	Cash, main account	100,000	
	1-50-15-01	Sales, div 15, wh 1		60,000
	1-50-20-02	Sales, div 20, wh 2		40,000

Record sales for 9/22 invoice processing

This account number structure uses a seven position account number to describe the important components of each transaction. In this example, the first position specifies the company that participated in the transaction (the organization operates several companies although only company number one has had sales transactions during this period). The next two positions identify the type of account that is being updated (10 stands for cash and 50 stands for sales). The next two positions represent the division responsible for the transaction (sales are subtotaled by division, but cash is maintained at the corporate level). Finally, the last two positions are used to identify sub-accounts. For the cash account, different bank accounts are identified with these positions. Different warehouse sales are identified in the sales accounts.

While this method of recording business transactions is still being used in most accounting systems today, the accountant's tools have changed radically over the last 100 years. First, mechanical devices, such as peg boards and writing boards, were developed in the late 1800's (Key 1993). With the introduction of such devices, clerical efficiency was improved. In addition, adding and posting machines improved mathematical accuracy and controls during the early 1900's. Computers have improved efficiency and accuracy even more. Computers have also made difficult and time consuming tasks (such as generating financial statements from the general ledger) very simple and almost automatic. They are able to store detailed information, to sort it in different sequences, and to provide different subtotals as needed. They have provided accountants the opportunity to expand their role in the organization beyond producing only financial statements and have enabled improved accounting techniques and support.

As a result, new demands are being made on accounting departments. For example, the chart of accounts may no longer be the only (or best) way for operational managers to categorize their organization's transactions. Rather than using financial statements that report summarized financial information on a periodic basis, managers are demanding non-financial information, different levels of aggregation for different managerial functions. They are also requesting reports in formats other than balance sheet and income statements (Davenport 1993).

Because of weaknesses inherent in ledgers, journals, and financial statements, accountants relying on them are unable to meet manager's new requests. For example, Table 1 identifies four major weaknesses that have been identified in the traditional accounting systems (McCarthy 1982). When data are stored in journal entry form, the

only information available consists of the general ledger accounts affected, the amount of the effect, and the date of the transaction. No additional information, such as detailed product, customer, or quality information is available. In addition, data are often summarized before a journal entry is entered into the system. As discussed, it is not uncommon for sales information to be summarized so only one journal entry updates the general ledger each day. As a result, detailed information is not available to managers. Similarly, the structure imposed by the chart of accounts limits the data categorization available to managers. For example, sales managers are able to determine daily sales for each division if their chart of accounts has separate sales accounts for each division. However, information about sales by customer or sales by product would not be available with this chart of accounts structure. Finally, because of the type of information stored in traditional systems and the level of aggregation required, it is very difficult to combine financial and non-financial information across the organization. As a result, organizations with traditional accounting systems often operate additional systems to provide the information necessary for other functional groups. These additional systems will contain redundant data that are often inconsistent and not able to interface with other systems.

Table 1
Weakness of Traditional Accounting Systems
(McCarthy 1982)

1. **Stored data have limited characteristics about transactions.**
2. **Data classification schemes are not always appropriate or supportive.**
3. **Aggregation level of stored data is too high.**
4. **Useful integration of financial and non-financial data across the organization is difficult, if not impossible.**

Andros, Cherrington and Denna (1992, p. 29) have identified other weaknesses of traditional accounting systems including that they do not support organizations' business processes, but rather "institutionalize antiquated, inefficient, and ineffective business processes." As a result, organizations often accept current processing methods rather than looking for more efficient procedures to "reengineering" their organization. One of the first examples of reengineering involves accounts payable processing at Ford Motor Company (Hammer 1990). Before reengineering, Ford, like virtually all organizations, performed three-way matching of purchase orders, receiving reports and vendor invoices before cash disbursements were made. After reengineering, Ford's management realized that the disbursement was the important event (rather than the matching of the documents), and that they had the information needed to prepare the disbursement upon receipt of the goods. Management reengineered the process, and now distributions are

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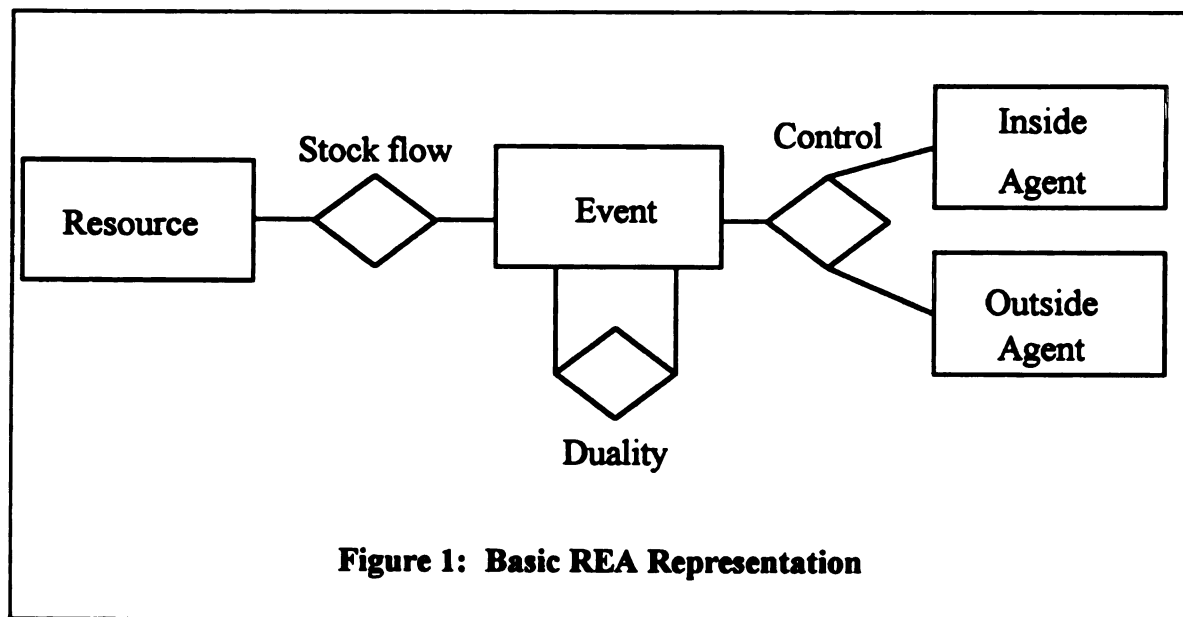
made to vendors upon receipt of goods. Vendor invoices have been eliminated from the process. After the process was modified, Ford's accounts payable department has achieved a 75 percent reduction in head count.

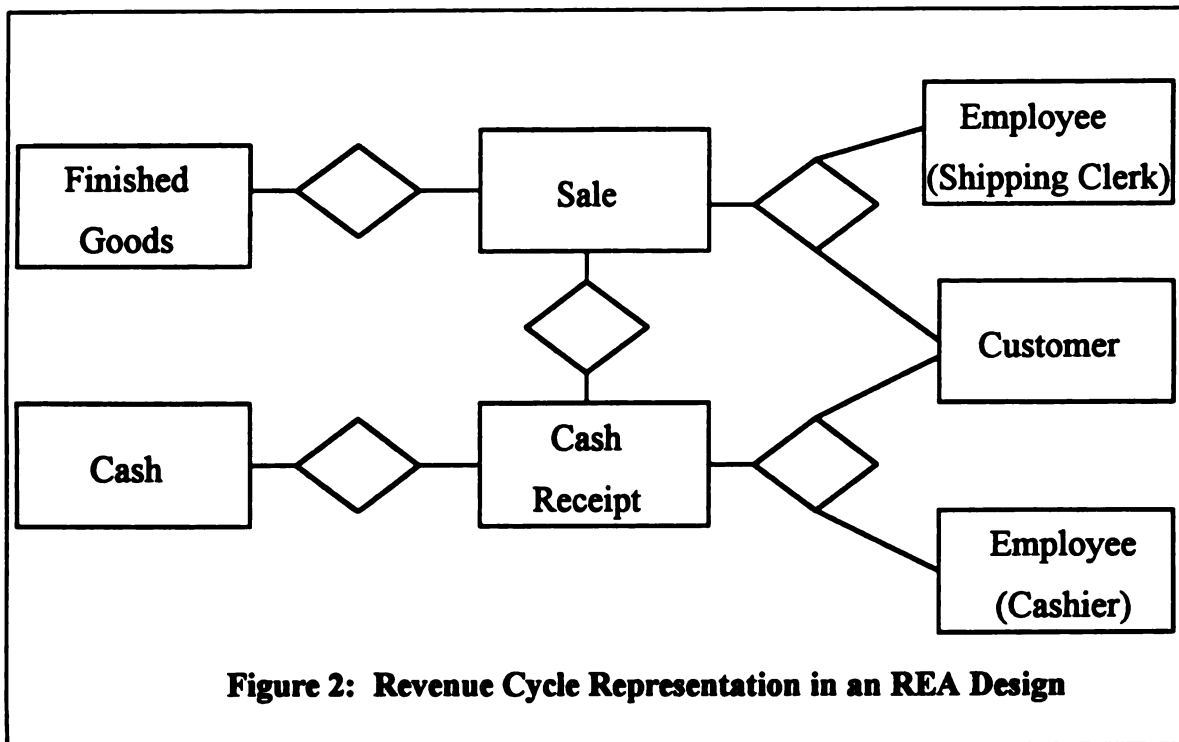
2.2 REA Theory

In response to the original weaknesses, McCarthy (1982) developed a new accounting framework referred to as REA. With this approach, accountants model reality directly by identifying the critical economic resources, events, and agents (hence the REA identification) in the organization's operations, rather than focusing on a chart of accounts. A resource is defined as something that provides value, is under the firm's control, and is scarce (Ijiri 1975). An event is an activity that increments or decrements an economic resource and results "from production, exchange, consumption and distribution" (Yu 1976, p. 256). Two agents, one internal and one external, participate in every event. For example, CASH may be identified as a resource. It is increased through an event called CASH RECEIPT in which a CUSTOMER (external agent) gives the organization CASH (resource); the CASH RECEIPT event is performed by an ACCOUNTS RECEIVABLE CLERK (internal agent).

In addition, the duality principle of REA recognizes the dual nature of exchanges. Events are paired so the inflows of every resource are coupled with outflows of another resource. For example, the CASH RECEIPT event increments CASH, and it is related to an event called SALE that decrements the resource INVENTORY.

REA systems can be documented with entity-relationship diagrams. Each resource, event and agent can be modeled as an “entity” (shown as a rectangle). The relationships between the entities are represented by diamonds. Figure 1 shows the “generic” REA diagram for an economic exchange. The diamond below the event entity models the duality relationship between increment and decrement events. By showing these duality relationships, this heuristic can be used to model all economic exchanges. For example, the REA diagram for the revenue cycle discussed above is shown in Figure 2.





If a complete analysis of the organization was performed, additional exchanges would be added to the diagram. For instance, if the company being modeled is a distribution company, then the INVENTORY would be incremented through a PURCHASE, which is related to a decrement, CASH DISBURSEMENT, of CASH.

Figure 3 is a model of a manufacturing firm. In this firm, raw materials are PURCHASED and then converted into FINISHED GOODS. Other exchanges modeled are FIXED ASSET ACQUISITION, SERVICE ACQUISITION, and EMPLOYEE SERVICE.

Figure 3: REA Model for a Manufacturing Firm

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Once the resources, events, and agents have been modeled, all of the necessary data about these should be identified. For example, all of the data about CUSTOMERs that would be required by sales, marketing, accounting, and any other organizational members should be identified. CUSTOMER attributes could include **name, address, credit limit, contact name, and phone number**. Similar analysis would be performed for each entity and relationship in the firm's entity-relationship diagram.

After the important data are identified, the organization's REA accounting database can be created by implementing each entity, relationship, and attribute in a centralized data repository. With application programs to enter, store, manipulate, and report this data, an REA accounting information system will include detailed information about the specific resources and people involved in the event as opposed to a traditional accounting system that includes only the transaction date, the account number, and the financial amount. In REA systems, both financial and non-financial information about events are accessible to all managers.

Continuing the earlier sales example, Figure 4 illustrates how an REA accounting system would record the same transactions that were summarized in the day's journal entry on page 5. The table shown is created for the SALE event. Attributes identified for this entity were **invoice number, invoice date, ship date, division, warehouse, total amount, and total cost**. In addition, the key attributes of the CUSTOMER and EMPLOYEE table have been included to implement the relationship between SALE and these entities.

Invoice #	Inv. Date	Ship Date	Division	Warehouse	Total Inv. Amount	Total Cost	Sales-person	Cust
1	9/22	9/20	15	01	\$ 60,000	\$ 30,000	1	C-05
2	9/22	9/22	20	02	\$ 15,000	\$ 10,000	2	C-10
3	9/22	9/22	20	02	\$ 25,000	\$ 10,000	1	C-10

Figure 4: Implementation of Sales Transactions in an REA Accounting System

The records in this table can be sorted and summarized to generate the same journal entry as in a traditional accounting system. However, additional “views” of the data are available for other system users with different information needs. This illustrates how REA accounting systems store much more data than traditional accounting systems. To a large extent, the main difference between an REA accounting system and a more traditional one is when data are “filtered.” In an REA accounting system, much less transaction data are filtered before they are stored. The majority of the filtering occurs when reports are generated, when only the information needed for the report is used. Continuing the SALE example, data can be grouped and summarized by **sales person** for the sales manager, or by **customer** for the marketing manager. If the relationship between SALE and INVENTORY is also implemented, the data may also be sorted by **product** for the production manager. In addition, the data can be summarized to prepare the financial statements when needed by management or to meet demands by outside institutions (such as the SEC, etc.). On the other hand, traditional accounting systems place a filter on the data before they are stored in the system. Therefore, the information that can be reported is limited to the account information that is stored in such a system.

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By implementing an REA accounting system, an organization can overcome the traditional accounting system weaknesses identified in Table 1. First, weaknesses one and four are the result of traditional accounting systems focusing on financial measures. REA systems store both financial and non-financial information about not only events but also the related resources and agents. By storing this information in one system, it is available to all system users, and REA accounting systems are able to summarize and report both types of data.

REA systems are able to minimize weaknesses two and three because they store detailed data about events and are able to produce different “views” of the data to meet various management needs. This feature of REA systems minimizes the problems with both data classification schemes and aggregation levels. REA data can be classified by attributes other than the general ledger account numbers. The data can either be aggregated in totals or studied as detailed transactions.

By focusing on REA modeling when designing a new system, organizations are forced to evaluate their business processes, thus overcoming the fifth weakness of traditional systems. By modeling each exchange in the organization, management has to identify all resources and processes used to produce value to the customer. Activities that do not provide value can be eliminated from the organization’s procedures (Geerts and McCarthy 1995).

Using REA methods to guide a systems analysis process results in a “directed” REA accounting system that meets the organization’s specific goals and is implemented without a chart of accounts. Rather, all of the event data are collected, and a computer procedure generates the financial statements.

Multiple directed REA proof of concept implementations have been reported in the accounting literature (Gal and McCarthy 1986; Denna and McCarthy 1987). These systems have been implemented in different processing environments, but both are able to generate financial statements without a chart of accounts. In addition, each has provided examples of how REA systems are able to meet other management needs. REA analysis is also being used by IBM. It is one of the design philosophies they are using to reengineer their accounting system (Andros, Cherrington, and Denna 1992). By focusing on their economic exchanges and attempting to simplify these processes and the systems that support them, IBM has been able to reduce the number of redundant systems used worldwide from 315 to 36.

In summary, research in REA accounting systems has been largely theoretical in nature. Starting with McCarthy (1979 and 1982), papers have described the REA framework and have shown how these systems overcome the weaknesses inherent in traditional accounting information systems. More recently, theoretical papers have applied REA to more challenging domains such as manufacturing, showing that this model is very robust (Grabski and Marsh 1995, Denna, Jasperson, Fong and Middleman 1995). In addition, several papers describe REA systems that serve as proof of the concept implementations such as Gal and McCarthy (1983). These research systems are able to store detailed transaction data and produce traditional accounting reports. Some papers also describe how these systems are able to meet additional management needs such as manufacturing decision support systems (Denna and McCarthy 1987) and strategy support systems (Revaz 1993).

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Weber (1986) reports the only empirical analysis of commercially available software. He studied several order entry systems to determine if these systems were similar to the REA systems recommended by McCarthy (1982). His results were that the systems did, in fact, keep detailed information that was consistent with REA at a high semantic level. However, at a lower semantic level, there were additional files that were necessary, such as customer orders and ship-to-addresses. For example, the systems he examined included CUSTOMER ORDERS. Although they have become important components of these systems, Weber noted that these are events that are not included in the basic REA template because no resource has been incremented or decremented. In addition, they are not they captured by traditional accounting systems. While Weber implies this is a weakness of REA systems, McCarthy (1982) had identified them as contracts and as a possible addition to the REA constellation. Weber also identified files that provided additional information about the resources, events and agents already identified by REA, such as ship-to addresses for CUSTOMERS and SALES. These are merely multi-valued attributes of the main entity to which they relate.

This work extends Weber (1986) in several ways. First, it examines the complete information system, rather than focusing on the data from one cycle within the system. Second, it studies the organization's systems at a high semantic level, rather than focusing on the data level. Third, it looks at how the systems are used in organizations, rather than studying vendor documentation. By doing this, the researcher is able to identify organizational characteristics that influence the way the system is used. Therefore, user's perceptions of the system and their self-reported uses of the system are also gathered.

In addition, this study categorizes systems along a continuum between traditional and REA accounting systems. The most traditional system, at one extreme of the continuum, would consist of only journals and ledgers and would use journal entries to produce financial statements. Directed REA systems, at the other extreme, would use REA to guide the system development, and the resulting system would not use journal entries to a general ledger to produce the financial statements. Rather, the system would produce them as a view from the detailed transaction data. To date, very few directed REA implementations have been described. The exceptions are implementations by the Price Waterhouse Geneva practice unit (Cherrington, McCarthy, Andros, Roth and Denna 1993) and IBM's implementation of the REA ideas (Andros et al. 1992).

Although none of the firms in this study operate accounting systems at either extreme of this continuum, a major goal of this study is to identify differences resulting from systems being more similar to either the REA extreme or the traditional extreme. As such, one of the contributions of this work is a more detailed, operational definition of the continuum between the extreme system types. This definition, described in the qualitative results sections of this dissertation, provides a framework for additional empirical research in REA systems and the potential benefits that they may provide.

Chapter 3 - Construct and Hypothesis Development

As discussed, accounting information systems have evolved over time. Hopwood (1987) described three common phases of information systems development. First, businesses were owned and operated by a single person who could easily measure the business' success since he or she was involved in all of the transactions. Once organizations grew too large to be monitored and controlled by an individual owner, however, management relied on traditional accounting systems. More recently, another shift has occurred. Information systems are broadening in scope to shift the focus from solely financial measures of the organization's performance to other measures such as quality and flexibility.

He did not know why these shifts occurred, nor did he make hypotheses regarding the environmental characteristics that would trigger these shifts. However, he realized that the changes occur because the firms enjoy benefits from the type of system they use. Many researchers have attempted to identify and quantify potential systems benefits. Two benefits that have been important to both researchers and practitioners are improved productivity and competitive position resulting from information technology. The following sections of this chapter provide a summary of these research areas and develop hypotheses for the current study.

3.1 Competitive Advantage

Organizations implement their strategic plans to improve their relative industry position (i.e., to gain a competitive advantage). By using information technology (IT) as a tool to support and reinforce an organization's strategy, firms can develop competitive

information systems (Huff and Beattie 1985). For example, the American Airlines reservation system (Sabre) was provided to travel agents so they could make reservations on-line (Wiseman and MacMillan 1984; Northrup 1991). This system enabled ticket agents to reserve tickets for any airline, but American flights were listed first. Their market share grew, largely due to ticket agent sales.

Porter (1985) identifies several strategies that can be used to highlight opportunities for competitive information systems. He states that IT can be used to raise entry barriers thus providing an advantage to the "first-mover" that adopts new technology. For example, the first firm that implements an REA system in an industry segment could store detailed information about customer preferences to improve customer service levels. Once customers expect this level of service, potential entrants into the market may have to provide similar services before customers would switch suppliers.

Second, IT can be used to increase negotiating power with suppliers. For example, if a firm's computer system is capable of storing price quotes from several vendors and vendor performance statistics, the firm will be able to negotiate more successfully with its suppliers (Porter and Millar 1985). If a firm's IT enables an organization to provide better service levels or improved flexibility, then the firm will enjoy increased bargaining power over its customers.

IT can also create new dependencies for customers by increasing the costs they would incur to switch to another vendor ("switching costs"). For example, American Hospital Supply (AHS) developed a system for their customers so they could log directly into the AHS system to check prices and product availability. Once the customers learned the system, they would incur costs to switch to another vendor who offered a different

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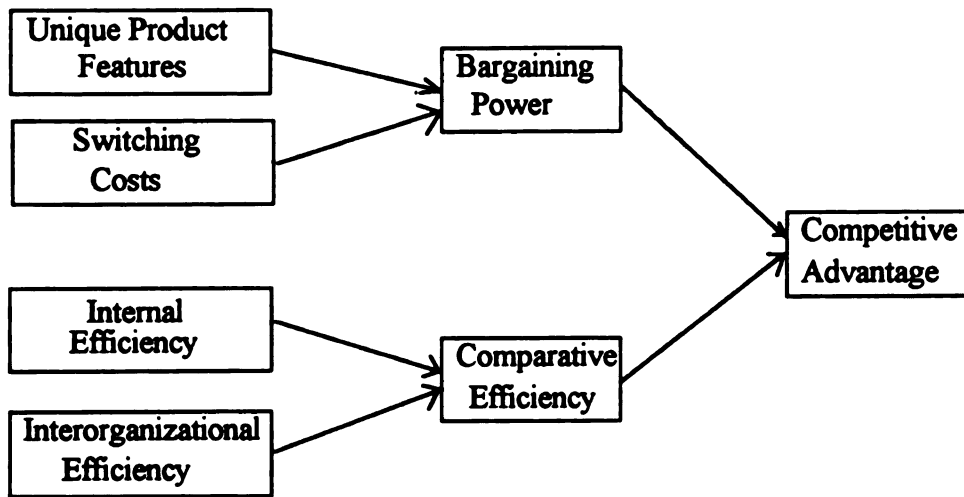
proprietary system. As a result, AHS enjoyed significant customer loyalty as long as their system continued to provide services similar to their competition (Porter and Millar 1985, p. 156).

Porter (1985) also states that IT can be a tool to develop new products or substitute products ("unique product features"). For example, Federal Express used technology to provide much faster and more reliable deliveries than its competition (Porter 1985, p. 171). IT can also create new business opportunities in "interrelated industries." These opportunities were very visible in the telecommunications and cable television industries. Dramatic changes are taking place in these industries as the telephone companies are broadening the types of services they offer beyond local or long distance telephone services. They are also attempting to influence federal regulations so they can enter the entertainment industry to provide cable television to customers using their existing infrastructure. Entertainment products and services are being modified with advanced computer technologies, and the distinction between these two industries is becoming less clear. It is also possible for firms to expand into industries in which their information system's data become a product that is sold to information brokers. For example, many information intensive companies such as grocery and retail chains have sold their sales databases for large, undisclosed, amounts of money to (LaPlante 1993).

In addition, by focusing on the production process during strategic planning, an organization may be able to identify ways to use IT to minimize the time needed to produce goods or to respond to changes in customer demands ("time efficiencies"). For example, a Computer-Aided Design/Computer-Aided Manufacturing (CAD-CAM) environment enables engineers to make modifications in product designs more easily.

Also, the system can automatically modify the production line to reflect these changes. This results in reduced costs for product changes and improved response time to customer requests.

While Porter's recommendations appealed to organizations and were used by researchers, they were not theoretically based. To fill this void, Bakos and Treacy (1986) used well-established theories to build on these recommendations and develop a model of how IT can lead to competitive advantage (Figure 5). They categorize the factors from Porter's (1985) framework and hypothesize that firms gain competitive advantage either by improving their bargaining power with external organizations or by improving their efficiency. The bargaining power hypotheses are developed using game theory in which information can enable one player in a zero-sum game to earn increased profits at the expense of the other player. They use transaction cost theory and bounded rationality to support comparative efficiency as a method to gain competitive advantage. Because managers have bounded rationality, an information system that decreases monitoring costs or enables evaluation of more alternative situations will help managers overcome their weaknesses and improve their decision-making process.



Source: Bakos and Treacy, 1986.

Figure 5: Causal Model of Competitive Advantage

To increase bargaining power, firms must either reduce the power their customers enjoy or improve their power over their suppliers. Firms can increase their bargaining power if they develop a product with unique features; then customers are not able to substitute competitor's goods. Similarly, if the firm can reduce its need for unique products, it will have improved bargaining power over its suppliers. Bargaining power is also improved by increasing customer switching costs or by reducing the costs of switching suppliers. Bakos and Treacy (1986, p. 113) describe strategies to increase customer switching costs as providing "unique and valuable information and services that require idiosyncratic changes to the customer's organization." As discussed earlier, the American Hospital Supply system provided this type of benefit.

Firms can improve their comparative efficiency by improving either internal efficiency or interorganizational efficiency. Internal efficiencies may be improved if a process is redesigned to eliminate wasteful steps and to automate the purely clerical ones. An example of an interorganizational efficiency is Electronic Data Interchange (EDI) through which electronic purchase orders are sent to vendors. This should reduce the total paperwork and clerical time required to place orders, resulting in direct and indirect benefits to both firms (Dearing 1990).

Bakos and Treacy (1986) also note that firms do not automatically enjoy competitive advantage from information technology. Specifically, they state that the link between technology must be strengthened with “strategy-literate information systems planners and technology-literate strategic planners” (p. 116). This was operationalized by David (1994) who defined a firm’s development characteristics as management’s philosophy about using information systems for competitive advantage and the approach they took when identifying systems enhancements to implement. This construct was significantly related to management’s perceptions of the system’s ability to provide its firm with competitive advantage.

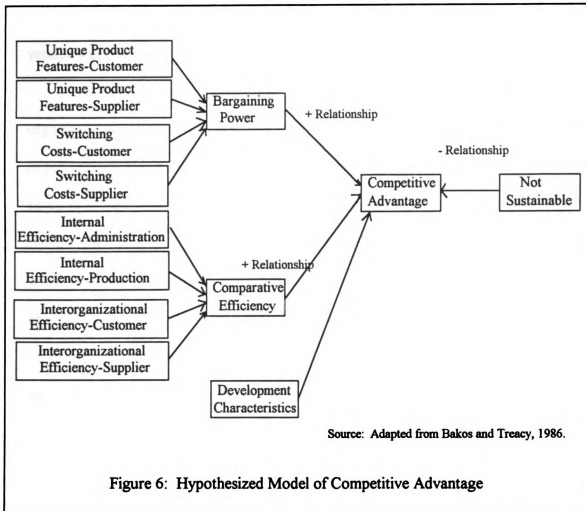
Although much of the literature has focused on the positive factors that may lead to competitive advantage, other articles have identified possible reasons why competitive advantage from IT may not be enjoyed. Several researchers (Porter 1985; Porter and Millar 1985; and Senn 1992) have been concerned that any system developed may be copied, so any competitive advantage created may not be sustainable. As a result, organizations implementing new technology may only be raising the costs of doing business for everyone in the industry. Once one firm implements a new system that

provides a temporary advantage, all other firms are forced to make similar investments. In the end, no firm enjoys an advantage, and all incur increased costs. This has been shown empirically in the hotel industry. Reid and Sandler (1992) conclude that hotel customers quickly treat technological innovations as required amenities during their hotel stays. Thus, total costs of operating hotels are increased, and none are provided with a competitive advantage. Because of these concerns, the belief that competitive advantage is not sustainable is hypothesized to be negatively related to managers' perceptions of competitive advantage.

The Bakos and Treacy model has been extended here to include *Development Characteristics* and *Not-Sustainable* as two additional factors that influence a firm's ability to enjoy a competitive advantage. In addition, firms may interact differently with suppliers than with customers, so the components of *Bargaining Power* and *Interorganizational Efficiency* have been divided. Finally, production or administrative staffs could become more efficient, so *Internal Efficiencies* has also been expanded. These changes result in the following hypothesis that is illustrated in Figure 6:

H1: Manager's perceptions of competitive advantage will be positively related to the ability of their systems to improve bargaining power, efficiency, and their organization's development characteristics. Manager perceptions will be negatively affected by the fact that advantages are not sustainable.

(*Competitive Advantage* will be positively correlated with *Development Characteristics, Unique Product Features, Switching Costs, Bargaining Power, Internal Efficiency, Interorganizational Efficiency, and Comparative Efficiency*. *Competitive Advantage* will be negatively correlated with *Not-Sustainable*.)



REA accounting information systems can assist managers in implementing each of the Bakos and Treacy (1986) strategies for competitive advantage. If an information system stores detailed event information, an organization using such a system could provide that detail to their customers who do not have sophisticated information systems. If customers value this information and can use it to improve their operation, they will see this service as enhancing the product they are purchasing. For example, if a customer's system does not maintain a detailed purchase history, the organization could produce monthly inventory purchase reports for the customer. This service would differentiate the organization's product from those of competitors. If customers rely on the information

available from the organization's proprietary information system, changing to another vendor will be more costly for the customer.

An REA accounting information system can have positive effects on an organization's internal efficiency. First, storing detailed event data centrally should result in productivity improvements by eliminating data redundancy. As a result, no effort is required to insure that separate systems are updated or remain consistent. This can reduce the amount of systems resources expended, and it may also reduce the control efforts needed to maintain the systems. For example, by eliminating redundancies, Du Pont was able to reduce the number of salary runs per year from 3,300 to 36 (Vincent 1993).

Second, new reports to meet specific information needs can be created more quickly than they could be with a system that stored only summarized data or data in different systems. For example, a sales manager may require a report that combines sales, inventory, and financial information. If all data are stored locally, it is much easier to produce this report than if the data are located on separate, independent systems.

Because management's ability is limited by bounded rationality, a system that provides information in a format that enables more efficient data retrieval should improve an organization's internal strategy (Bakos and Treacy 1986). By design, REA accounting systems should help management "plan, monitor and control" the key events of the enterprise (Denna, Cherrington, Andros and Hollander 1993). Therefore, management should perform their tasks more effectively, and outputs generated should increase or required inputs should decrease. For example, if provided with better inventory and production information, management should be able to identify problems in the production process more quickly. If they have the information necessary to correct the situation, they

may be able to significantly reduce the amount of scrap material used to produce the finished goods. Overall, the production department would be more efficient.

Denna et al. (1993) also recommend performing “reengineering” as a critical step in the REA accounting system design process. Reengineering involves analyzing the organization's processes to eliminate nonessential processes or events, to improve essential process efficiency, and to enable new valuable processes. Throughout the reengineering process, design participants are encouraged to think creatively about their business events and attempt to make “radical” changes to the processes. For example, Davenport (1993, p. 1) recommends organizational improvements through “efforts to achieve 50%, 100% or even higher improvement levels in a few key processes.” If process reengineering is successful, significant efficiency improvements should occur because the overall result is more streamlined processes that are only performed if they provide value to the customer.

Finally, an REA accounting system may improve interorganizational efficiencies because the detailed transaction data are available for analysis. For example, Motorola transformed its business to improve customer service levels, thus improving the efficiencies between itself and its customers. Their system is able to process “nontraditional information” including product quality data. When the organization was implementing its quality programs, the former chairman asked for the quality reports to be presented first in the monthly management meetings, and he left before the financial information was presented. Because of this shift in focus toward quality, the number of defective products has been reduced by a factor of 100 (Vincent 1993).

Because of the varied effects that REA systems should have on the organization, and the weaknesses inherent in more traditional accounting systems, the following hypothesis is tested:

H2: Executives of firms that have implemented REA systems will perceive that their systems provide more competitive advantage than executives using more traditional systems. (*Accounting System Characteristics* will be positively correlated with *Competitive Advantage*.)

3.2 Productivity

Productivity is defined in the labor economics literature as “how much output can be produced with as few inputs as possible” (Panko 1991, p. 192). Normally measured in units, productivity measures focus on the quantity of inputs and outputs, rather than their dollar value. Therefore, they can be used to monitor an organization’s success in producing goods. While there have been different levels of productivity studied, the definition of productivity used in this study is taken from Davidson (1993). He defines productivity measures at the company level, while efficiency is measured at a functional level. For example, if front desk clerks are able to check in more guests after an information system is implemented, then they are more efficient. On the other hand, if the total number of labor hours per guest night is reduced, then the hotel firm’s productivity has improved.

In the aggregate, productivity measures have been used to monitor and evaluate the economy’s ability to produce goods. For example, the U.S. Department of Labor’s

Bureau of Labor Statistics (BLS) measures productivity in the U.S. economy and in segments of the economy. Researchers have used these measures to identify the "productivity paradox" -- white collar employee productivity seems to be decreasing while, simultaneously, large computer expenditures have been made to increase their productivity. Roach (1991), for example, found that although service industry firms have purchased relatively more technology than manufacturing firms, their productivity has been poorer.

This result has puzzled researchers. However, Panko (1991) identified several problems with the BLS statistics that were used in the early productivity studies. First, the BLS has difficulties measuring units of outputs. Often constant-dollar sales are used as an estimate for units produced, but both the sales figures and the deflation indexes may introduce measurement errors to the productivity figures reported. For industries such as not-for-profit and government, sales figures are not available, so the BLS estimates outputs as equal to inputs. As a result, productivity for these segments never changes from unity. Many segments of the service industry produce outputs that are difficult to identify at all. For example, how would an accounting firm's output be measured? Should the number of audits be used? A weighted measure that considers the size of the audit? Audit revenues? Industries that present significant measurement problems (including finance, insurance, real estate) are omitted from the BLS figures.

Another problem with aggregate productivity figures is that organizations may substitute one input factor for another. For example, if a computer system is implemented to reduce the number of people needed to package and ship merchandise, additional personnel may be needed at the main office to maintain the system. As a result, if the

number of orders shipped remains constant, the productivity for the office workers will appear to decrease. However, the productivity of the factory workers would simultaneously increase.

In addition, Brynjolfsson (1993) identified four potential explanations for prior productivity research results: (1) mismanagement of firm resources, (2) lags between computer-related expenditures and productivity improvements, (3) measurement errors, and (4) redistribution of resources within industries. He provided detailed examples of each potential explanation and discussed the research approaches that could be used to evaluate them.

Mismanagement of assets can occur if the managers approve computer expenditures that improve their situation (status, slack time, etc.) while hurting the company's financial position. If this is the cause of the productivity paradox, then there are no benefits in productivity from computers for firm owners.

Lags may occur because unproductive activities occur at the time of new computer implementations. For example, training time may be necessary to prepare users for system changes. When examining productivity levels during training, the number of labor hours (including training) will increase without an increase in output. Also, the new users may not be as productive at the time of implementation because they have not yet learned the intricacies of the new system. Another cause in productivity lags is that the system implementation may be phased in over time. If any of these lags occurs, one would not be able to measure the productivity improvements until some time in the future. Kelley (1994, p. 1420) provides evidence of lags. She compared the productivity levels for several firms that had implemented programmable control systems in manufacturing

processes and found that companies that had recently implemented such systems had not experienced as much productivity improvement as earlier implementers. She asserts that there is a lag between the time of implementation and productivity improvement; the recent implementers had yet to experience the improvement since they were still in the lag phase.

Measurement errors may occur in two ways. First, the researcher may be examining data that are too aggregated (such as BLS statistics) so the effects of the computer are not measurable. Brynjolfsson and Hitt (1993) use firm-level computer expenditures and sales figures to estimate the productivity provided from the computer investments; they find a significant, positive relationship between the two. Second, the researcher may be using inappropriate productivity measures. For example, some researchers have used functional-level measures in their productivity studies. If researchers used “checks cashed per hour” as a measure of bank teller productivity,¹ they would not be able to identify productivity improvements arising from an ATM implementation. In fact, they may determine that the tellers are less productive after the ATM is implemented because many customers will use it for simple transactions, and the tellers will handle the more difficult ones. Therefore, the teller may process fewer checks after the implementation than before.

It is possible that IT does not increase the overall size of an industry, but rather shifts the market share among the firms in the industry. Brynjolfsson identifies this as the redistribution effect of IT since firms that successfully implement technology may be able

¹ Notice that this is actually an efficiency measure using the definitions in this study.

to increase their sales by taking sales from other firms in their industry. There are many researchers who have argued that information technology (IT) can provide competitive advantage for individual firms (Porter 1985; Johnston and Carrico 1988; Johnston and Vitale 1988). If this is so, firms with a competitive advantage may be the ones using IT to improve their productivity. Firm-level measures would identify this type of productivity improvements, whereas summary measures would show no productivity improvements.

Different methodologies may be able to reduce the mismeasurement and redistribution difficulties encountered in prior research. If only computer systems with certain characteristics provide improvements, studies looking at more aggregated data may not be able to identify any consistent impact of computers on productivity. By focusing on the systems themselves, researchers may be able to identify the significant characteristics that result in improved productivity.

As already discussed, having all data centrally located and available to all managers can reduce both system processing costs and management effort. Therefore, both managers and the information systems department can be more efficient. If the managers are more efficient, and none of the other workers become less efficient, then the company's productivity level will improve.

In addition, if a directed REA design is performed to develop the system, each business process will be analyzed, unnecessary steps will be eliminated, and opportunities for information technology to streamline the processes will be implemented. This will result in internal efficiency improvements throughout the organization, and improvements in the firm's productivity.

The previous discussion leads to the third hypothesis:

H3: Firms with REA systems will be more productive than firms that use more traditional accounting systems. (*Accounting System Characteristics* will be positively correlated with *Productivity*.)

3.3 Summary

The three hypotheses are summarized in Figure 7. As shown, this model identifies an additional research question: Do REA systems have a direct impact on competitive advantage and productivity, or are they affecting bargaining power and comparative efficiency directly and competitive advantage and productivity indirectly? If there is a direct connection between REA systems and competitive advantage, such a link would provide evidence that the model proposed by Bakos and Treacy is missing critical constructs that lead to competitive advantage. Therefore, in addition to testing the individual hypotheses, this exploratory path model will be tested as Research Question 1 (RQ1).

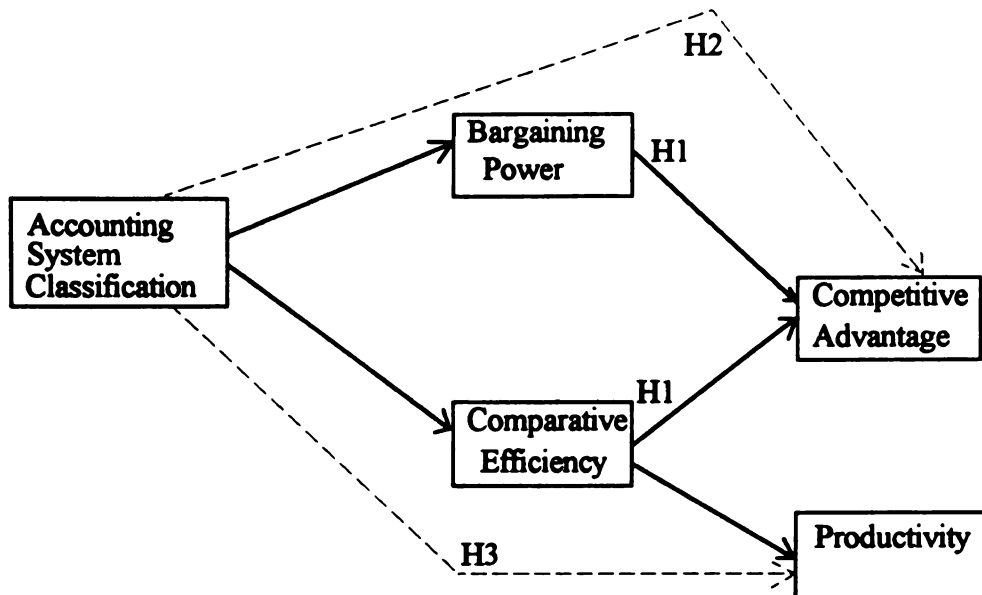


Figure 7: Hypothesized Model of the Impact of REA Systems and RQ1

Chapter 4 - Methodology and Construct Development

4.1 Introduction

While three hypotheses and a research question have been developed and are the focus of the quantitative results reported, there are additional, qualitative goals of this study. Most importantly, this study operationalizes the classification of current systems along a continuum between traditional and REA accounting information systems. While the extreme ends of the continuum have been defined in previous literature (McCarthy 1982), the systems that fall in the middle have not been categorized. Therefore, a metric was developed to capture the important information systems characteristics and to enable the researcher to draw conclusions about those that provide organizations with benefits. In addition, the results of the study are used to propose a more precise definition of the characteristics that differentiate systems along the continuum.

These goals describe the cyclical nature of research. First, hypotheses have been developed using existing theories and these are tested quantitatively. Second, the results of the study are used to provide a more thorough model of information technology and to identify the characteristics of REA accounting information systems. These characteristics are used to develop a model that hypothesizes relationships between each of the characteristics and potential benefits to the firm. This model can be used as the foundation for future research continuing this research stream.

These goals are best met using a field study methodology. As discussed in Trewin (1988), field-based research allows the researcher to examine organizations and how organizational characteristics affect the success of their information system. This is important when examining benefits derived from systems with specific characteristics

because it is likely that these systems only provide benefits to organizations with certain characteristics. In addition, she cites Yin (1984) who says that field-based research can be used not only for hypothesis testing, but also for categorizing phenomena and building new hypotheses. In summary, field studies are the appropriate research methodology to study “a research issue in transition, for which grounded theory or experience with relationships among well-defined variables have not yet emerged” (Gosse 1993, p. 166). This is certainly the case with REA accounting systems.

To meet the research goals, field research was performed to gather detailed information from eight firms regarding their information systems characteristics and how their systems affect both their productivity and their perceptions of competitive advantage. To focus the field inquiry, four guidelines were followed (Gosse 1993). First, all of the sites were selected from the pulp and paper industry, and all have approximately the same level of sales. This minimizes confounding differences between the sample firms. Second, to control the interview environment, measures of *Competitive Advantage* and *Accounting System Characteristics* were developed and used to guide the discussions with firm personnel. Third, to increase the “richness of the data” open ended questions were included in the questionnaire. Subjects were encouraged to speak freely and add insights to the discussion. Finally, the data gathering procedures included interviews with people across both functions and management levels within the organization. Individual interviews were held with the goal of understanding system impacts on each person. The group discussion at the end of the visit was used to confirm patterns that had emerged in the data.

4.2 Construct Development

Two questionnaires were developed: one categorizes the firm's information systems and the other measures executives' perceptions of competitive advantage. The methods used to produce each will be discussed in the following paragraphs.

4.2.1 Accounting System Characteristics Questionnaire

As discussed in Chapter 2, most of the work in REA systems has been theoretical in nature. Therefore, it was necessary to develop an instrument that would categorize information systems by placing them along the continuum between traditional accounting information systems and REA systems. The survey was developed to incorporate the following characteristics that were identified in the theoretical works as important in REA systems:

- No chart of accounts. Produce financial statements from detailed event and resource data.
- Support the organization's critical events.
- Store detailed data about the resources, events and agents.
- Store non-financial information about resources, events and agents.

The survey uses a generic REA diagram for a manufacturing firm as its foundation. It was developed in three phases. First, an REA model for a manufacturing firm was developed. Next, this diagram was modified to incorporate contract events identified by Weber (1986). The conversion cycle was then modified, by collapsing several events. For example, the full REA diagram included two events for a raw material issue: an issue of

raw material from the raw material storage area and an issue to work in process. These two events were replaced with a single raw material issue event since they normally occur simultaneously. Finally, full tracability was not enforced and resources such as “advertising benefits” were eliminated since they are difficult to identify in practice.

The resulting diagram is used to identify business-critical events and it is modified if the organization operated differently than the generic one. Once the organization’s REA diagram is established, the information system is analyzed to determine if it supports each entity on the diagram. A system would move toward the REA end of the continuum with each event that it supports.

Questions were written to measure key characteristics of the accounting department. For example, it is important to determine how the financial statements are generated. Firms that do not have a general ledger would automatically be placed at the REA end of the continuum. In addition, however, several accounting department characteristics were identified that would provide evidence that the system was more traditional or more REA. If the company uses a very detailed chart of account structure that incorporates many codes in each account, it is more likely relying on the traditional accounting methods. Therefore, it would be classified as closer to the traditional end of the continuum.

Finally, it was recognized that a system could be purchased from a vendor and that it would have inherent characteristics that placed the software itself at a point along the continuum. However, how the system is used depends on organizational characteristics such as complexity, computer availability, speed of processing, flexibility of data retrieval, etc. Therefore, the questionnaire includes an additional section to identify user’s

information needs and how the system is used. This section includes questions about the processes the respondent performs. The next questions identify what information the respondent needs to perform their daily functions and where it is available. In addition, there are questions about whether the information system improves their productivity and asks them to identify enhancements they would like to see in the system.

People from several functional areas were asked these questions. Their information system's score was increased if it was able to provide the information needed to perform daily functions. However, if the system did not provide information that would have been available in an REA system, the information system's score was reduced.

Questionnaire evaluation was performed in two phases. During the first phase, the researcher completed the questionnaire for several firms that would not be included in the main study. With each completion, the questionnaire was scored, and the results were discussed with several researchers familiar with REA systems. The questionnaire was then modified to gather additional information about the organization and their system, or the questions and scoring were modified to improve the metric's ability to rank systems along the continuum.

The second phase of testing involved systems consultants from one of the Big 6 accounting firms. The consultants listened to a two hour seminar about REA accounting systems. After the discussion, they were provided with a randomly-numbered, blank questionnaire. They were asked to complete the functional questions from an order entry clerk's point of view. One half of the consultants were asked to complete the questionnaire for the information system that they were currently replacing at one of their clients. The other half completed it for the new system that was being recommended for

their clients. Additionally, they were asked to estimate how they would score the system using a scale of one to seven where a one signified a traditional accounting information system and a seven signified an REA accounting information system. They wrote these scores on a separate sheet that also included their random number.

These questionnaires were scored, and the systems were ranked based on their scores. Of the fourteen consultants that participated, the questionnaire scores ranked the systems in the same order as the consultant's estimates with only one exception. Upon analyzing that consultant's score and questionnaire, it was determined that the consultant did not understand REA accounting systems.

The final survey (Appendix A) includes (1) the generic diagram, (2) additional questions about the system, accounting and MIS, and (3) the form that was used to interview the functional employees (both staff and management level) within the organization. The number of points added or subtracted to the organization's total score may seem arbitrary. However, based on the pilot test results, the scoring system adequately differentiated between the information systems.

4.2.2 Competitive Advantage Survey

A survey was developed to measure executive's perceptions of competitive advantage (Appendix B). The *Development Characteristics* and efficiency questions are those used by David (1994) to analyze how the executives of small, fast-growing firms perceived comparative efficiencies and competitive advantage from information technology. These questions were developed using the methods described by Moore and Benbasat (1991) to improve internal reliability of the survey. First, five questions were

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written for each construct and were placed on individual note cards. These note cards were distributed to students who placed them into categories for each related topic. The first students to sort the cards read them and created category names in which to place the questions. After their categorization was analyzed, the questions were re-written to improve their understandability. Additional groups of students were provided with the questions on note cards plus a list of the constructs and their definitions. This process was continued until three questions consistently were placed into the correct category.

To complete the *Competitive Advantage* portion survey, additional questions were written for *Unique Product Features* and *Switching Costs*. Since each firm may have different relationships with their customers and suppliers, five questions were written for *Unique Product Features-Customer*, *Unique Product Features-Supplier*, *Switching Costs-Customer*, and *Switching Costs-Supplier*. Thus, twenty potential questions were written, and the same procedures were performed to verify the reliability of them. As a result, twelve more questions were randomly added to the first portion of the survey. Confirmatory factor analysis was performed on the survey responses to verify the metrics internal reliability and validity. This procedure and its results are discussed in Chapter 5, section 5.2.1.1, Factor Analysis of Competitive Advantage Metric.

Also included in this survey are questions that measure the *User's Satisfaction* with the system. Seddon and Yip (1992) developed these questions to directly measure *User's Satisfaction* with general ledger accounting systems. Seddon and Kiew (1994, p. 10) recommend them as a "short, simple measure of IS success." In this study, they are used to confirm any positive perceptions of *Competitive Advantage* that are identified during the interview process.

These four questions were also presented to all staff level employees who participated in the study. To collect their perceptions, a one page questionnaire with a brief instruction section was prepared. See Appendix C for a copy of this metric.

4.3 Efficiency and Productivity Measures

The demographic information provided by the organizations is used to measure their efficiency and productivity. Efficiency is defined as the number of output units from a department or function divided by the number of units of input from the same function or department. In this study, the efficiency of the order processing department is measured as the number of orders divided by the number of order entry personnel. The accounts payable department can be evaluated with the number of checks written divided by the number of employees. Similar measures are available for accounts receivable and production.

Productivity is a firm level concept, so overall input and output quantities are needed to measure it. Firms participating in the study were asked to identify the unit of measure they used to track output and the number of units produced over the last five years. In addition, they provided sales figures which are often used as a proxy for units of output. Input would be measured as total number of employees and the hours they worked annually, the total number of administrative hours annually, and the total number of factory employee hours. All of this information was collected with an introductory questionnaire that was sent to the company before each visit began (Appendix D). The goal was to have them complete this metric before the visit began.

4.3 Methodology

4.3.1 Sample

Potential firms in the paper industry were identified through several sources. First, the *Standard and Poor's Register of Corporations, Directors, and Executives* (1993) was used to identify firms in the Pulp and Paper SIC codes, located in the Midwest and Northwest, with sales of \$10 to \$500 million. Executives of these firms were sent letters of introduction.² After two weeks, the executives were called to schedule a site visit and to gather preliminary data about the organization's information systems. This methodology generated three firms in the study. In addition, firms that had executives who were board members of the Retail Packaging Manufacturer's Association (RPMA) were contacted. The RPMA is a trade association that provides resources to its members. For example, it distributes a newsletter that discusses operations, management and information technology, and trends in the industry. One RPMA firm is included in the sample. Finally, firms were included through word of mouth. After the first few firms had participated, they recommended additional firms and made calls of introduction.

This method of sample selection may bias the results. Each of the firms that participated had a management team that was willing to commit considerable amount of firm time to the project. They were all interested in receiving an evaluation of their system and learning about other systems in the pulp and paper industry. Therefore, the perceptions of these executives may be different from those of managers in the total

² This industry was selected because the researcher has experience here.

population. However, the state of REA research requires detailed information about operational systems and their uses. Therefore, this methodology and its inherent problems are deemed appropriate. Future research promises to extend this work to confirm it in larger samples or to identify characteristics that differentiate these sample firms from the general population.

4.3.2 Site Visit Procedures

Each firm was scheduled for a two-and-a-half day site visit. Before the visits began, the contact person from the company was asked to complete both a tentative schedule (Appendix E) and an initial questionnaire (Appendix D) that was used to collect the detailed demographic information about the firm. These forms were to be returned to the researcher before the visits. The schedule was required so the organization's personnel were aware of the time required for the analysis.

Each visit included a tour of the manufacturing facilities and an initial meeting to introduce the researcher to the management-level participants in the evaluation. During this meeting, the competitive advantage surveys were distributed. Depending on the time available for the meeting, the executives either completed it during the meeting or before they met individually with the researcher.

During the remainder of the first two days, the researcher met individually with both managers and staff employees of the organizations. She carried a laptop computer to each of these meetings and typed the interviewee's responses as the system and organization was discussed. It was determined that this typing was less obtrusive than breaking periodically to enter or write the responses. In addition, this enabled the

researcher to keep very detailed notes of conversations, attempting to transcribe them verbatim. These discussions were used to evaluate the organization's system and classify it along a continuum as an REA system or traditional system.

To measure the system characteristics, she interviewed the executive responsible for the information system and studied the system documentation.

To evaluate the organizational characteristics, she also interviewed managers and staff in the key functional areas: sales, purchasing, production, and distribution. Since the organizational structure differed between firms, the exact titles and levels of employees varied. For example, one organization did not have a purchasing department. Instead, purchasing was performed by several people. The goal of these meetings, therefore, was to meet with as many people with the widest range of responsibilities as possible.

By interviewing several users of the system and by having executives from different functional areas complete the competitive advantage survey, individual biases will be reduced (Sethi and King 1994). For example, the executive responsible for information systems may believe that the system is providing more competitive advantage than the other executives who do not have any direct ownership in the system. The methodology used in this study will reduce the impact of such biases.

The last half day of the visit was used to hold a seminar for the firm's management team. This seminar accomplished four objectives. First, it provided an opportunity to gather any missing data before leaving the firm. Second, it enabled "de-briefing" of the executives, and the researcher was able learn more about their perceptions of their information systems. Third, it allowed managers to correct any misconceptions the researcher had about the firm. Finally, it gave the researcher an opportunity to provide

some service to the firms. This session was a selling tool that persuaded several of the executives to participate in the study.

Because these sessions needed to meet each firm's goals, the sessions were tailored according to management's instructions. As a result, different firm members attended the meetings. In some organizations only top management was involved; in others the MIS staff was present; and in others all of the study participants were included. During most of these sessions, the researcher provided a summary of the competitive advantage and REA literature as it relates to information technology. In all cases, she presented an initial analysis of the firm and its information system and highlighted potential opportunities for improvement. She also was able to print a document of the Accounting System Characteristics questionnaire that had been completed during the visit and to provide it to management. A final version was sent at a later date after it had been edited more thoroughly by the researcher. In addition, several firms were interested in selecting new software, so discussions about beneficial selection procedures were often included. Throughout, the researcher focused on the advantages of an REA-like system and on the comments that had been presented by the study participants.

In virtually all cases, the management was enthusiastic about this closing session. They were intrigued by the concepts of REA, and they could easily understand their systems representation in the generic REA diagram. In addition, they were impressed by the documentation of their system, and the researcher's ability to consolidate so much organizational information after only two days at the firm. Therefore, the survey metric that was developed provided benefits to the organizations participating in the study, and at

least five firms are interested in having the researcher perform ongoing, periodic analyses over the next two years.

Chapter 5 - Data Analysis and Results

During the eight company visits, detailed information was gathered about each company and its system. The company information included operational and financial statistics, plus organizational structure, management philosophies, user perceptions, and process flow analysis. Because both quantitative and qualitative data was collected, several analysis techniques are used to evaluate the effects that the accounting information systems had on the organizations. These results are reported in the three main sections of this chapter. In the first section, the qualitative results are discussed and used to develop an operational model of the characteristics that differentiate traditional and REA accounting information systems. The second section discusses the statistical tests performed on the data to evaluate the hypotheses developed in Chapter 3. The final section discusses the results, focusing on how the quantitative results may be explained or reinforced using the qualitative insights gained during the site visits.

Because each company visit was performed using the same questionnaire, the similarities and differences between the firms were identifiable. In addition, each organization had developed unique computer solutions to best meet the needs of their employees and management. Section 5.1 presents the qualitative results of these company visits. The first part of this section describes the systems characteristics that affected user satisfaction. The important characteristics that differentiate systems are defined. Potential benefits from each characteristic are discussed and current literature is examined for studies to evaluate these characteristics and provide empirical evidence about their effect on organizations. This information is used to develop a detailed model of the characteristics that differentiate systems

along the traditional and REA accounting information systems continuum. Next, organizational characteristics that affected the choice of accounting information system are presented. These organizational characteristics provide logical reasons for the adoption of systems that would otherwise be viewed as sub-optimal.

Section 5.2 of this chapter presents the quantitative results to determine if the systems that are more similar to REA systems are providing firms with more benefits than the more traditional systems. It describes the confirmatory factor analysis process used to evaluate reliability of the *Competitive Advantage* and *User Satisfaction* metrics. Regression analysis is used to test hypothesis one: improved bargaining position and comparative efficiencies lead to competitive advantage from information systems. Path analysis is used to identify the effect of REA versus traditional accounting information systems on competitive advantage. In addition, correlations are presented to show the effect of accounting systems characteristics on different efficiency and productivity measures.

The final section of this chapter discusses the implications of the qualitative and quantitative results. While the data provides evidence that more advanced systems provide improved administrative efficiencies, they do not appear to aid in implementing interorganizational strategies for competitive advantage. Organizational and systems characteristics may affect both manager's perceptions of their system and the benefits that current systems actually are providing.

5.1 Qualitative Results

The *Accounting Systems Characteristic* questionnaire, developed prior to the site visits, provided the structure for each of the visits. The researcher used it to first identify the key business events, and then to gather information about how the firm's information system processed these events, what data were stored, and how this information was translated into financial statements. In addition, the questionnaire was used to gather user satisfaction information from several systems users at different levels within the organization.

By using a consistent approach for each of the site visits, patterns about the organizations and their systems emerged. This was especially true when the generic REA diagram was modified to reflect the individual processing environment for each firm. These diagrams enabled communication of detailed information about the organization and the processing environment. They were frequently used as a focal point of the de-briefing seminars at the end of each visit, and were used as the foundation for the qualitative analysis that follows. (See Appendix F for each of the firm's diagrams and summary scoring sheets.)

5.1.1 Key Systems Characteristics

When the site visits were completed, the researcher compiled and compared the *Accounting System Characteristics (ASC)* questionnaires from all of the firms. Each firm's employees had discussed what information they used and where it was available. They also identified weaknesses of their current systems, and systems enhancements they would recommend. The researcher focused on the differences between the systems and the user's perceptions of them. She could then identify patterns of characteristics that differentiated the

firms with the more sophisticated systems from those with the more traditional systems. As a result, seven key systems characteristics were identified (see Table 2). The following sub-sections define each characteristic in terms of traditional versus REA accounting information system, using examples from the companies visited and evidence from other empirical studies that have evaluated similar characteristics.

Table 2:
Key Characteristics to Differentiate
Traditional and REA Accounting Information Systems

1. Support all critical events.
2. Store a detailed history of events.
3. Store the data in an integrated data repository.
4. Have the ability to retrieve and manipulate the data to meet users needs.
5. Process the events as they occur.
6. Directed REA design and implementation.
7. Prepare the financial statements without journal entries and a general ledger.

5.1.1.1 Support Critical Events

The theoretical definition of REA includes definitions of events and the duality relationship between events which increment and decrement resources; a system's ability to process information about these events is thus an important feature of REA accounting systems. Using this as the foundation of REA accounting information systems, an important

component of the *Accounting System Characteristics* questionnaire was identifying events that were and were not supported by the firm's information system. Each event that was not supported was crossed off the generic E-R diagram for the firm. During the site visits, it became apparent that this process identified significant system weaknesses that were the focus of user dissatisfaction. For example, purchasing was performed manually by several organizations. At Ann Arbor the purchasing director performed all inventory functions by keeping a manual inventory book with a page for each raw material and finished good. This process had a large, negative effect on several other departments in the organization. When a customer placed an order, the customer service representative wrote it on an order form which was passed to the purchasing director. He checked the availability of raw materials. If available, he wrote the allocation in the inventory log and reduced the quantity available; if not available, he placed a purchase order and updated the inventory sheet with the expected purchase quantity. He returned the customer order form to the order clerk who examined any notes from purchasing, and passed the form to an order entry clerk for entry into the system. This process often took several days before the order was entered into the system. A similar procedure was used to maintain the finished goods log.

These manual procedures caused many problems for the firm. First, the purchasing director spent virtually all of his time maintaining the manual records and preparing manual reports for accounting to calculate cost of goods sold each month. Second, the firm was not able to process customer orders as quickly as they would have liked because there were bottlenecks in the system. Third, because several processes were manual, the information was not available to other employees who could have used it to better plan their activities. For

example, production did not have access to information about upcoming orders. Therefore, it was common for customer materials needed for a production run to arrive at the plant before the production manager was aware of the customer order. When this occurred, it took time for the receiving clerk to discover the source of these materials and to determine storage and scheduling requirements. Finally, it was difficult to identify and measure inventory problems because they were often hidden in the manual processes and logs.

It is also important that the system not only process the events, but that it processes them adequately so the business can be supported. In the case of Columbus, the management team had selected a software package and had implemented most of the functions. However, because the system did not process customer orders or purchase orders sufficiently, there was a considerable amount of manual processes that were performed in addition to the automated process. In this company, the system was not able to reduce the amount of work needed to process an order or to order raw materials. Management felt it either had not provided efficiency improvements or had in fact reduced these functional area's efficiencies.

Information systems that process key events have been hypothesized to lead to efficiency improvements. For example, Kelley (1994) discusses the difficulty in linking information systems to improvements in productivity because there are many confounding factors that influence a firm's inputs and outputs. However, she hypothesizes that firms should enjoy efficiency improvements, but only from systems that either automate a process or improve the capabilities of existing machinery. Because a key feature of REA systems is that they automate and support an organization's key processes, her hypothesis can be restated that REA systems will provide greater internal efficiencies than traditional systems. In

addition, if all of the key processes are included in the system, the firm's productivity may also improve.

Because of both the theoretical definition of REA accounting information systems and the problems experienced at most of the firms that did not process all of their events on the system, the first key characteristic of REA systems is that all of the major business events are supported by the firm's accounting information system. This is measured by adding points to the systems *Accounting Systems Characteristics* score for each key event that is supported, subtracting points from the system's *Accounting Systems Characteristics* score for each key event that is not supported.

5.1.1.2 Detailed History of Events

REA systems must not only process key business events, but must also store detailed history records of the them for a significant period of time. The theoretical papers describing REA systems rely on this feature for the financial statement generation; without detailed history records, a system would not be able to generate a financial statement view without some type of general ledger file. In addition, it is recognized that maintaining detailed records will overcome many of the aggregation and classification weaknesses inherent in traditional accounting systems.

This feature was also identified by the management of several of the companies included in this study as a source of benefits from the system. For example, one of Madison's recent systems improvements was to enhance the sales module to store two year's detailed sales information. In addition, a complaint expressed by many of their employees was that

there were only three months of purchasing and inventory history. Because of this data shortage, time was often spent sorting through manual files to identify inventory sources and tracking inventory histories. Management felt that a system that maintained complete inventory histories would provide significant efficiencies to the firm.

The company with one of the most advanced systems had four years of order history available on-line to their order entry clerks. This information allowed the order entry clerks to answer customer questions while the customer was on the phone, and re-orders could be entered more quickly. In addition, detailed sales analysis could be performed to understand sales trends and to identify key customers.

Keeping a detailed transaction history in the system is another theoretical tenet of REA accounting systems. It would be this history that would be used to materialize the financial statements. As a result, this has been identified as the second key characteristic of accounting systems. To measure this feature, the length of time that transaction history is kept on the system is written by each event. If any company-specific events are implemented in addition to the generic events, more points are awarded for those events that have history stored for over one year than for those with less than one year's history.

5.1.1.3 Integrated Data Processing

Integrating data in a central storage location is an important characteristic of database systems, which was the foundation for the initial REA research. In these systems, data redundancy would be eliminated, and the data could be available to all systems users. This

feature was important to several organizations, and has been identified as the third key characteristic of REA systems.

In this study, several companies operated more than one system to meet their needs. If there were multiple systems, it was common to have redundant data and redundant processes to store the data required in each system. In the extreme, Bloomington had a system that was designed by the corporate office, and they were required to use it for order processing. However, this system did not keep any quality information or results of tests that were run at the end of each production run. Therefore, their management team hired a consultant who developed a personal computer application to store and report this information. They had another customized personal computer application to store sales analysis data. In this company, similar data were entered into all three systems. Several people who were interviewed commented on how they needed all of the data, but they also complained the process to maintain the data was cumbersome and inefficient.

Movement toward integrated systems has been documented in the pulp and paper industry with the introduction of mill-wide control and information systems (MCIS). These systems process information throughout the mill, and have been shown to improve quality, flexibility, efficiency, and on-time deliveries. In addition, firms using them have enjoyed cost reductions and increased information distribution (*Technology and Labor in Pulp, Paperboard and Selected Converting Industries* 1994). These systems are similar to REA systems as they are integrated systems that process events as they occur. While none of the companies in this study have implemented this type of system, three have implemented technology that performs real time monitoring and control of the production process, and one

of these has integrated this information into its main accounting information system to update production records.

Integrated data is a system characteristic that has been hypothesized and shown to lead to several benefits. Porter and Millar (1985) identified integration as a key to gaining competitive advantage. They stated that information technology needed to aid organization-wide communication if the firm was to receive benefits from its implementation (and that decentralized systems would not provide as many benefits as integrated ones). In fact, they state that “unless the numerous applications of information technology inside a company are compatible with each other, many benefits may be lost” (p. 159).

Another benefit of integrated systems was documented at Conoco where an integrated expert information system was implemented and used throughout the world. Belcher and Watson (1993 p. 249) found that the integration of information from around the world was “helping people feel more connected and informed,” and, as a result, it provided a “boost to the morale of the group.” While it is difficult to translate this type of intangible benefit to either competitive advantage or productivity improvement, the Conoco executives believed that this was a true benefit of the system and that it could lead to other more tangible benefits.

If the systems are not integrated, there are potential difficulties with insuring that redundant data remains consistent across the systems. Fisher (1994) states that this can cause inefficiencies for both the firm’s computer personnel who have the “hassles of maintaining multiple information systems” (p. 75) and their auditors who are faced with the problem of reviewing both systems to determine which number is correct. As a result, integrated systems can lead to improved control and less attestation risk.

Again, REA systems would, by definition, maintain all of the data in a central data repository, and there would be applications that enabled data entry to the repository. Therefore, this has been identified as the third characteristic of REA accounting information systems. The *Accounting Systems Characteristic* questionnaire deducts points from firms that operate multiple systems. First, 2 points are subtracted for each time (after the first) that users would have to log into the systems. In addition, if users would have to physically log into multiple terminals, five points are subtracted for every system after the first. This scoring metric means that firms that have one integrated system will have higher *ASC* scores than those that use multiple systems being run as a somewhat integrated system in which the users use one terminal, but have to log in several times. Both of these types of firms will have higher scores than firms that operate multiple distinct systems.

5.1.1.4 Data Availability

Storing the data is just one step in making it valuable to the organization. There must also be a means to retrieve and manipulate that data to provide users with information. Similar to data integration, data availability is an underlying assumption of well-designed database systems. REA systems, therefore, would provide users with a method to retrieve the detailed data about resources, events, and agents that is maintained in the system.

The firms in this study had different levels of data accessibility, and unavailability often resulted in user complaints. In one case (West Lafayette), all of the sales transactions were entered into their accounting system, and over two years' data were being stored. However, the system the firm used was a personal computer program that was not able to be networked.

As a result, the accounting clerk used the machine throughout the day to enter all of the transactions, to produce invoices and checks, and to produce the monthly financial statements. No one else had access to the system, and people who needed sales information were required to maintain spreadsheets for themselves. When orders were placed, the sales staff first entered them into at least two spreadsheets, one for the total order that was sorted by customer, and another that stored the sales detail for each item sold. Then the order was forwarded to the accounting clerk for data entry.

East Lansing, although operating a system that integrated most of the critical events, had similar concerns. Their system did not have a report writing facility, so much of the sales analysis and production data was not available to executives. As a result, they were very dissatisfied with their system, and they were considering purchasing a new one that would provide access to the information they wanted to better manage their organization.

The spirit of REA accounting information systems stresses the ability to provide financial and non-financial information to all users in the organization. Therefore, the fourth important characteristic of an REA system is that there is a method of data retrieval. This retrieval method could be pre-programmed reports or inquiry screens, or it could be a facility that enables users to ask questions and structure the answers that they need. While the report-writer capability enables more specific reports and may be able to provide more information, it demands a high level of training to be effective. Columbus has this type of program, but only the controller had the background necessary to use it. As a result, he infrequently created new reports, and once they were created, they were run at scheduled times. To the user's point of view, these reports were very similar to the programmed reports that came with the software.

The amount of data availability is measured in the *Accounting Systems Characteristics* questionnaire by asking the users what information they use and where they locate it. If the information is retrieved from the system (either through a report or an inquiry screen), positive points are awarded to the system, moving it closer to the REA end of the continuum. If, however, the data is not available to the user, but it would be if the system were an REA system, then points are subtracted from the system's score.

5.1.1.5 Real time processing

REA systems are designed following a model of the real world they represent. For the information stored in these systems to reflect the real world, it is important that they be updated as the real world changes, i.e., that they have real time updates to the data. This is different from traditional accounting systems that embody batch processing to improve data accuracy and to simplify the recording process. Therefore, the fifth key feature of REA systems is that they process transactions as they occur.

The importance of this characteristic was evident at the companies with the most sophisticated systems. These organizations had systems that had been customized to process non-traditional business events such as customer quotes and ink formulation, but the users were still dissatisfied with their systems. The main reason they gave was that the data in the system were not up-to-date. At Madison, inventory was updated by batch programs, rather than with real time updates. As a result, the inventory quantity on hand in the system was virtually always missing information on either purchase receipts or raw material issues. It was not uncommon for four people (the production manager, the purchasing manager, and two staff

people) to walk into the warehouse to check the availability of a key material needed for the day's production.

Even when the system processes most transactions in real time, there can be concerns. At Champaign, the major complaint was that there were only daily updates to both the raw materials issued to jobs and the jobs as they moved through production. Each roll of paper was assigned a roll tag. When the roll was used in a process, the tag was removed and put in a bin to be entered into the system. A new tag was created for the resulting product that could become a raw material for another step in the process. All of the day's tags were entered during the afternoon. Customer service people complained that they were not able to answer questions with up-to-date information. Scheduling was concerned because it could not see if the jobs scheduled were actually completed.

These are examples of complaints arising from systems that process key events and store the transaction detail for future inquiries. However, their weakness is that this transaction information is not available as it occurs. This is another important characteristic that differentiates REA systems from more traditional ones. An REA system is one in which the database is generated from a model of the business, and the data should reflect reality to as great an extent as possible. This feature is not measured directly in the *Accounting Systems Characteristics* questionnaire. However, for future research it would be possible to add two steps in its completion to capture this information. First, batch updates could be identified on the generic REA diagram by drawing dashed lines between entities that have lags between events and the updating of the resource and agent data. For example, if receiving information is not entered and updated in real time, then a dashed line would be drawn between the

PURCHASE event and the INVENTORY resource. Second, a set number of points could be subtracted for each event that is not updated in real time.

5.1.1.6 Directed REA Design and Implementation

The next important characteristic in the definition of REA systems is that they should be designed following the REA template. If this occurs, the economic events will be identified along with their related agents and resources. In addition, the duality relationship between events identifies the resources that are “given up” in order to “get” each resource. By analyzing these exchanges, management can evaluate whether the exchange is economically beneficial to the firm. When the system is implemented, the business process should be designed to streamline each of the exchanges. Next a centralized database to store the important information about the exchanges should be designed. Finally, the data would be up-to-date and available to system users.

While this type of design had not been performed at any of the organizations, it was the process used when making recommendations during the final seminar that presented the results of the systems analysis. In several cases, the REA diagrams and philosophy sparked ideas for systems improvements. For example, after discussing the revenue cycle at Ann Arbor, they realized that they could enter the shipping information in the warehouse as the goods were leaving the property. This would result in at least three benefits. First, the invoices would be generated and mailed a day earlier, thus improving cash flow from receivables. Second, the system would be updated so customer service would know accurate

order status information. Third, management would have access to sales figures more quickly.

If a company performed a directed REA design and implementation, the resulting system should encompass the earlier key systems characteristics. However, implementation compromises may occur if the organization determines that the costs of developing such a system would outweigh the expected benefits. Regardless of the compromises, the *Accounting Systems Characteristics* would award positive points to firms following the design approach, which would be recognized as a re-engineering exercise. As such, systems resulting from this type of design would move more toward the REA end of the continuum, regardless of the final compromises that were necessary.

5.1.1.7 Elimination of Journal Entries

The final characteristic of REA accounting systems is that they do not generate journal entries or maintain a general ledger. Rather, the financial statements are the result of view materialization of the detailed transaction data stored in the system.

As expected, none of the organizations participating in this study had systems such as these. However, the executives participating in the final sessions were interested in the implications of such systems. Although their systems used journal entries to update a general ledger, they were able to identify areas in their current transaction processing systems where the data was available to produce financial statement information. For example, the CEO at East Lansing explained that their current system stored all of the detailed sales information and could be used to prepare the sales portion of the income statement; he believed that their

transaction processing systems embodied many of the key features of REA systems. In fact, he was correct as their system was scored at the top of those included in this study.

The research that looks at systems that do not use a chart of accounts or that have been developed using a directed REA approach is limited. To date, the only published work is that by Andros et al. (1992) who discussed the reduced number of systems that resulted and the improved flexibility and efficiency enjoyed by IBM with the implementation of systems that were developed following the REA approach. A major reason few researchers have evaluated REA systems is that there have been very few directed REA implementations. As they become more common, it will be important for researchers to evaluate their success, identifying the costs and benefits of implementing and maintaining them.

To identify firms that have implemented a system that has adopted all of the REA characteristics, the *ASC* questionnaire includes a question about how the system generates financial statements. If the system does not use journal entries, 100 points are added to its *ASC* score. This would insure that the system's score would be significantly higher than any other that had not been the result of a complete REA implementation.

5.1.1.8 Summary

These key characteristics (refer back to Table 2 for a summary) result in an operational definition of REA systems. This definition can be used in future systems evaluations because the accounting systems characteristics construct will no longer have two well-defined values: traditional or REA. Rather, there are specific features of the systems that are along a continuum.

5.1.2 Key Organizational Characteristics

One of the advantages of field-based research is that it provides opportunities to study the interaction between the organizations and their systems, rather than studying the systems in isolation. When the site visits had been completed, it was possible to compare the organizational characteristics that had influenced each organization's systems decisions. It became evident that the management teams were trying to make the best systems decisions for their organizations, regardless of the system's sophistication. In addition, organizational characteristics influenced management's perceptions of their systems. As such, examining the system in isolation would not provide a complete view of the organization's system. Instead, the key organizational characteristics must be considered. Therefore, key organizational characteristics (see Table 3) have been identified. The following sections discuss each of these characteristics and their potential influence on the measurements and quantitative results presented in this dissertation.

Table 3: Key Organizational Characteristics

- 1. Complexity.**
- 2. Size.**
- 3. Organizational structure.**
- 4. Technical sophistication.**
- 5. Costs versus benefits.**

5.1.2.1 Complexity

Although the firms in this sample were selected from the same industry to minimize confounding factors, it was evident that some of the firms had more complex processes than others. Complexity in this study is defined as the type of manufacturing process that is performed, the number of products produced, and the number of outside agents that interact with the organization. It became evident during the site visits that complexity influenced the type of system that was needed to manage the organizations, as firms with more complex environments implemented and supported more advanced systems.

For example, the system used by West Lafayette earned the lowest *ASC* score, but management was satisfied with its performance. They used a single personal computer to operate an integrated, off-the-shelf accounting program. All sales analysis reports that were needed had to be generated from spreadsheets. However, management was able to successfully control their business using this system because the business was not very complex. They sold only 15 products and did very little development of customer-specific products. They produced twelve of their products on-site, and the production process had only five steps. For their remaining products, they performed a limited amount of assembly, relying on vendors for most of the production. Management believed that they were able to monitor the organization's progress with the information available. In addition, they had estimated the costs of maintaining additional spreadsheets as considerably less than the costs of implementing a new system.

It is possible that sophisticated systems cannot be cost justified in organizations that do not have complex operations. For example, Porter and Millar (1985) claim that opportunities for competitive advantage are most likely to arise in organizations that operate with “information intensity.” Examples of information intensity include using a large number of suppliers and/or customers, producing goods in many distinct product categories, producing products that require many parts or many steps to complete, and producing products that have a long cycle time.

5.1.2.2 Size

The size of an organization will also influence the type of system being used. Larger firms in this sample had in-house MIS departments and were apt to modify their software to meet new needs. They used technology to help monitor their processes, and to summarize the large number of transactions. Their management believed that this type of technology was able to improve efficiency and effectiveness, thus providing a positive return to the firm. Managers of many of the smaller firms felt that investment in production technology was able to provide a larger return than investment in information technology. Therefore, these smaller firms were willing to accept pre-programmed software, and they modified their procedures to work around any system irregularities.

In both cases, the management believed they were making a justified systems decision for their firms. Therefore, the smaller organizations perceived their system to be “adequate” for their present environment. The size of the organization, therefore, will influence management’s decisions and their perceptions of their information system.

5.1.2.3 Organizational Structure

The organizational structure also imposed systems constraints on individual business units. If a firm is composed of several divisions, the amount of centralization will have an effect on the system and how closely it mirrors an REA system. By having additional business units, the parent organization has to weigh the benefits of having a centralized, integrated data base, with the costs of possibly not processing the individual business units transactions in most efficient manner.

For example, if the firm imposes a structure at the corporate level, then all of the divisions will use that system, and the information can be consolidated and integrated for use at the corporate office. However, the systems may not be tailored to the individual business units, and it will not be able to adequately process their key business events. This was evident in this study, as Bloomington was required to use their parent company's order processing system, even though it did not provide them with all of the sales information their management and customers required. Similarly, Champaign included a small division that is a distribution company for products used in conjunction with those produced by the main division. Managers of this smaller division were constrained because they had to use the system developed for the manufacturing firm although they themselves did no manufacturing.

On the other hand, allowing each business unit to establish their own information system will result in two potential costs. First, the costs to develop the individual systems could easily be greater than the cost to develop one system that would then be used at all sites. Second, consolidating the divisional data from distinct, different systems will be more

costly than transferring similar data from each of the divisions. For example, Madison had purchased a company that was located out of state. It was allowed to continue to maintain its old system, but this resulted in monthly manual processes to transfer the divisional information to the centralized accounting information system.

5.1.2.4 Technical Sophistication

Management of the firms in this study exhibited a wide range in technical philosophy. Some of the companies employed managers who were very technically aware, and these companies were more likely to implement more advanced systems. In each case, there appeared to be a technology “champion” who was able to evaluate technological innovations and who could communicate expected benefits to the rest of the organization’s management. They were able to convince the management team that new technology was possible to implement in their organization, regardless of its size, and that the benefits would outweigh the costs.

Most interestingly, managers in these firms were able to identify many more weaknesses in their current systems, and they were not satisfied with how they performed. Their *Competitive Advantage* scores were driven down by the few systems shortfalls they had focused on, rather than the wide range of functions the system was adequately providing. These managers were aware of new, more sophisticated technology, and they felt theirs was already out of date. In several cases, they were pleased to hear from the researcher that their system was a leader in the industry; they had not realized that they were so far in front of their competition.

5.1.2.5 Costs versus Benefits

Finally, it appeared that firms were willing to work with their current system until the benefits of replacing it would clearly be greater than the costs. Before this occurred, they would develop non-integrated personal computer applications that would support the organization where the main system could not. For example, Evanston had developed a personal computer application that would store Bill of Materials and Operations List information about each product. Although they would have preferred to integrate this with the order entry and inventory modules of their main system, they did not have the in-house expertise to modify their main system, nor did they feel that purchasing a new system would be cost effective. However, management believed that, if the organization continued to grow, they would need a new system for better maintenance of specific information, along with more detailed inventory and purchasing information.

These cost-benefit decisions will result in an organization's *ASC* score changing over time. When a new system is first implemented, it is likely that it will meet most of the firm's needs. Therefore, it will exhibit many of the characteristics of an REA system: it will process key events, and store the detailed data in a centralized location. However, as the weaknesses in the system become apparent, and stand alone applications are developed to overcome them, the *ASC* score will decrease; more systems will be needed to satisfy users needs. When the system becomes so inadequate that another is purchased, there will be another jump in the *ASC* score. In all cases, the system in place may be the most cost effective for the firm at that point in time.

5.1.3 Summary of Qualitative Results

By comparing and contrasting the firms and systems in this study, the author was able to identify key characteristics that influenced successful systems implementations. First, a more specific operational definition of REA systems was developed using the key systems characteristics. In general, it is hypothesized that firms using systems incorporating more of these characteristics will enjoy greater benefits than firms using systems that are more like traditional systems. However, it is important to recognize firm-wide characteristics that may influence an organization's systems choice. Therefore, a list of organizational characteristics that were important to this study's firms was presented and discussed.

5.2 Quantitative Results

The goal of this section of the dissertation is to gain a better understanding of benefits that arise from systems that are more similar to REA systems than those that are more traditional. Specifically, it has been hypothesized that more advanced systems will enable firms to enjoy competitive advantage and improvements in productivity. The following sections describe statistical tests that were performed to provide evidence about these hypotheses. In each section, the analysis relies on the quantitative data that was gathered from the organizations during the site visits.

5.2.1 Preliminary Data Analysis

Several preliminary data analysis activities were required before the hypotheses could be tested. First, the Competitive Advantage Survey was analyzed to determine if the questions asked were representative of the different factors in the Bakos and Treacy model. Factor analysis was performed to identify the model of *Competitive Advantage* that should be used for the hypothesis analysis. Section 5.2.1.1 describes these procedures. In addition, factor analysis was performed on the User Satisfaction responses received from the executive and staff members who participated in the study. The results of this analysis are presented in Section 5.2.1.2.

5.2.1.1 Factor Analysis of Competitive Advantage Metric

After the site visits were completed, factor analysis was used to verify the validity of the questions in the Competitive Advantage survey. Confirmatory factor analysis was used since the questions had been developed to measure specific, theoretically defined constructs. As such, the questions could be grouped by factor in the Bakos and Treacy model.

Fifty-nine executives had completed competitive advantage surveys during the site visits. Of these, four had missing responses for several questions, so they were omitted from the analysis. The remaining fifty-five responses were used in the factor analysis. These respondents were executives in the firms who had managerial responsibilities for various functional areas. By having from executives across functional areas complete the questionnaire, the summarized perceptions would be less biased. For example, one would expect that the MIS Director would believe that the system was providing competitive

advantage. In addition, if the system supported customer service adequately, the executive responsible for this area may have similar impressions. However, if the system was weak in manufacturing processing, the executives responsible for this area may identify systems weaknesses that the others would not. The author's goal was to have each company represented by the same number of executives from the same functional areas. Because several firms had different organizational structures, this was not possible. For example, two firms did not have purchasing departments established, but had purchasing performed by various other executives. Similarly, several firms did not have a manager of distribution. Therefore, participation was tailored to the firm's organization with the goal of including executives from a wide range of functional areas. Several of the organizations had multiple sales and marketing executives who were responsible for different product lines or customer bases; therefore, the sample includes more sales and marketing executives than other functional areas. Table 4 provides information regarding the survey respondents.

Table 4**Executives Who Completed the Competitive Advantage Survey**

Number of Respondents/Company	
Mean	6.88
Minimum	3
Maximum	9
Respondent's Functional Areas:	
	<u>Number of Executives</u>
CEO/Owner/Partner	4
Customer Service	3
Distribution	5
Finance/Accounting	7
Management Information Systems	3
Production	8
Purchasing	5
Sales/Marketing	15
Other	<u>5</u>
Total	<u>55</u>

The methodology used to identify the specific questions to be included in the competitive advantage analysis is similar to that of Sethi and King (1994). Correlations between the question responses were calculated, and the resulting correlation matrix was used to perform factor analysis of five constructs: *Unique Products*, *Switching Costs*, *Internal Efficiencies*, *Interorganizational Efficiencies*, and *Competitive Advantage*. Six questions had been written for each of the competitive advantage strategy constructs, and three were included for *Competitive Advantage*. All of the questions in the survey were written to determine if the firm's information system contributed to the firm's competitive advantage or individual strategy. Therefore, when executives agreed with statements in the survey, they

were not only saying that the firm enjoyed competitive advantage (or unique product features, etc.), but that their system helped them achieve this status.

Confirmatory factor analysis was performed to determine if there were five factors that were measuring the five constructs in the Bakos and Treacy model. The questions from the survey were identified as indicators for one of the five factors in the model. The factor analysis results were analyzed to identify questions that were inconsistent with the factor they had been written to represent. The first level of analysis focused on the errors between predicted correlations among the questions in each factor and the actual correlations from the data. The predicted correlations were calculated using the Internal Consistency Theorem that posits that the correlations between indicators within a factor should be equal to the product of each indicator's correlation with its factor (i.e. $r_{ij} = r_{iF1} * r_{jF1}$). Questions that had significant errors were analyzed to identify ones that should be removed from the study. This was an iterative process, removing one question from the model each time and performing the analysis again. This isolated each question's effect on the constructs and overall model, and the procedure continued until there were no significant errors between the actual and expected correlations between the questions. Table 5 shows the correlation matrix of the independent factors and the questions that were included at the end of this phase of the analysis.

The second level of reliability analysis was to calculate Spearman Brown's Standard Score Coefficient Alpha for each factor. Except for *Switching Costs*, the alphas for the factors were over 0.75. Because of the low reliability of *Switching Costs*, this factor was removed from the analysis.

The final level of reliability analysis was to perform additional tests to determine if each factor was internally consistent, testing if the questions within each factor were unidimensional and parallel. Unidimensional means that each of the indicators within the factor relate to the other indicators of the factor similarly. Parallelism means that all of a factor's indicators are similarly related to the other factors in the model. This analysis showed that all of the factors were internally consistent, except *Internal Efficiencies*. The indicators of *Administrative Efficiency* were measuring a construct different from those questions written to measure *Production Efficiency*. Therefore, the construct was changed to measure only *Administrative Efficiency* and was limited to questions 4 and 9 from the survey.

The test for parallelism failed for the *Unique Product* factor, and it was determined to be similar to the *Interorganizational Efficiency* factor. These two factors were therefore combined, and the analysis was performed again. At that time however, the resulting factor failed to be internally consistent, i.e., the indicators of this factor were not measuring one underlying construct. Bakos and Treacy had identified difficulties in differentiating the various strategies that involve firms within the value chain. They recognized that the different strategies firms use to gain competitive advantage may often occur simultaneously and that their effects may be hard to segregate. For example, they describe a situation in which a product innovation could improve production efficiency, enhance product uniqueness, and increase customer switching costs. Because firm strategies may encompass several of factors in the original Bakos and Treacy model, the empirical model was modified to include only two independent factors: *Internal Strategies* and *Interorganizational Strategies*.

Table 5: Correlation Matrix for Questions in a Four Factor Model

	Question Number															
	U								S							
	6	23	19	29	8	11	27	1	4	9	3	13	21	32	33	36
6		49	60	38												
23	54		51	33												
19	60	46		40												
29	33	33	44													
8	2	14	7	5		17	34	30								
11	10	-1	27	55	21		4	4								
27	-4	-1	44	41	30	5		7								
1	-38	7	4	26	33	-2	8									
4	-19	37	14	30	6	31	-6	13		68	46	40				
9	-26	31	14	14	16	35	7	9	81		50	44				
3	32	-25	-21	-3	13	31	-7	-2	36	46		30				
13	-44	22	26	23	25	28	15	21	36	34	43					
21	-35	34	17	42	41	17	25	5	18	15	38	39		44	41	35
34	34	-19	-16	-26	34	33	29	1	14	26	35	34	35		62	53
33	-36	25	21	23	33	48	30	14	25	32	27	39	42	71		49
36	-25	20	29	37	28	39	7	9	26	29	38	37	44	54	40	
U	76	65	79	50	10	34	30	0	23	12	-6	10	22	-10	12	23
S	-16	10	45	69	120	14	28	25	24	37	19	49	48	53	68	45
IE	-21	24	12	23	22	46	3	15	79	86	58	51	40	40	45	48
IOE	-22	22	18	27	49	49	33	10	30	37	50	54	54	82	76	65

Numbers in the Question columns are correlations. The triangle below the open diagonal shows the actual correlations between the indicators multiplied by 100. The triangles above the diagonal show the predicted correlations multiplied by 100. There were no significant errors between actual and predicted.

The last four rows are the factor loadings for a four-factor model. Factor loadings in italics identify the questions predicted to form each factor.

Spearman Brown's Standard Score Coefficient Alphas:

U (Unique Products): .766 IE (Internal Efficiencies): .773
 S (Switching Costs): .429 IOE (Interorganizational Efficiencies): .785

These factors were analyzed using the same procedures as described above. First, the six questions relating to *Internal Efficiencies* were identified as those for *Internal Strategies*, and all of the questions for *Unique Products*, *Switching Costs*, and *Interorganizational Efficiencies* were combined for the *Interorganizational Strategies* factor. The iterative analysis of errors between expected and actual correlations was performed, and the constructs were tested for internal consistency and parallelism. After several iterations, it became clear that the administrative efficiency questions identified one factor, while the production efficiency factors were more similar to the *Interorganizational Strategies* construct. Therefore, the *Internal Strategies* factor was renamed *Administrative Strategies*. Table 6 shows the predicted and actual correlations for the *Interorganizational Strategies* factor in the resulting model. Table 7 shows the internal consistency analysis for both *Administrative Strategies* and *Competitive Advantage* factors. Because there were fewer than four indicators for these factors, they were analyzed by comparing predicted and actual correlations for questions *outside* of their factor. The predicted correlations were calculated as $r_{if} = r_{iFi} * r_{jFj} * r_{FiFj}$.

Table 6: Correlations for Interorganizational Strategies in the Modified Model of Competitive Advantage

	IOS										AS					CA			
	5	23	19	29	12	27	17	21	34	33	4	9	16	22	24				
5		23	30	26	19	18	33	28	24	22									
23	21		34	29	21	20	36	31	27	24									
19	30	46		38	27	26	47	40	34	31									
29	24	33	44		23	23	41	34	30	27									
12	24	35	19	15		16	29	25	21	19									
27	5	-1	44	41	16		28	24	21	19									
17	28	30	51	36	40	14		42	37	34									
21	16	34	17	42	22	25	55		31	28									
34	38	23	36	13	19	23	53	30		24									
33	37	25	21	23	13	30	20	42	16										
4	6	37	14	30	2	-6	16	18	-12	25									
9	48	31	14	14	-7	7	16	15	-5	32	81								
16	40	27	38	11	31	16	61	59	43	39	36	30							
22	56	31	14	23	17	16	53	60	38	38	34	39	76						
24	44	23	27	12	25	25	60	37	66	36	2	12	59	59					
IOS	46	51	66	57	41	40	71	60	52	47	24	31	69	65	67				
AS	30	38	16	24	-3	1	18	18	-9	32	90	90	37	41	8				
CA	58	33	33	19	30	24	72	64	61	47	30	33	87	87	68				

Where: IOS = Interorganizational Strategies

AS = Administrative Strategies

CA = Competitive Advantage

The lower triangle of this chart shows the actual correlations between the indicators multiplied by 100. The upper triangles show the predicted correlations multiplied by 100. Any significant differences between predicted and actual correlations are highlighted by an asterisk.

The last three rows are the factor loadings for a three-factor model. Factor loadings in italics identify the questions predicted to form each factor.

Spearman Brown's Standard Score Coefficient Alpha for *Interorganizational Strategies* is 0.797.

Table 7: Consistency Analysis for Administrative Strategies and Competitive Advantage

<u>Actual Correlations</u>		<u>Predicted Correlations</u>	
<u>Administrative Strategies</u>	<u>Competitive Advantage</u>	<u>Administrative Strategies</u>	<u>Competitive Advantage</u>
<u>Q</u>	<u>16</u>	<u>4</u>	<u>16</u>
<u>5</u>	<u>40</u>	<u>9</u>	<u>22</u>
<u>23</u>	<u>27</u>	<u>13</u>	<u>33*</u>
<u>19</u>	<u>31</u>	<u>14</u>	<u>37</u>
<u>29</u>	<u>38</u>	<u>18</u>	<u>48*</u>
<u>12</u>	<u>11</u>	<u>16</u>	<u>41*</u>
<u>27</u>	<u>31</u>	<u>11</u>	<u>30</u>
<u>17</u>	<u>16</u>	<u>11</u>	<u>29</u>
<u>21</u>	<u>61</u>	<u>20</u>	<u>51</u>
<u>32</u>	<u>59</u>	<u>17</u>	<u>43</u>
<u>33</u>	<u>43</u>	<u>15*</u>	<u>38</u>
	<u>39</u>	<u>13</u>	<u>34</u>
			<u>27</u>
<u>4</u>	<u>36</u>		<u>27</u>
<u>9</u>	<u>30</u>		<u>27</u>
<u>16</u>	<u>34</u>	<u>27</u>	<u>27</u>
<u>22</u>	<u>39</u>	<u>27</u>	<u>27</u>
<u>27</u>	<u>12</u>	<u>21</u>	<u>21</u>

Predicted correlations are calculated as $r_{ij} = r_{Fi} * r_{Fj} * r_{FFj}$
 * Designates significant error between predicted and actual correlations.

Spearman Brown Coefficient Alphas:
Administrative Strategies 0.895
Competitive Advantage 0.846

The three factors were also tested to determine if they were uniform and parallel. In each case, they were both. As such, the data collected from the executives in this study better fits the modified model of *Competitive Advantage* in which firms select either *Interorganizational* or *Administrative Strategies* to earn competitive advantage. Because the data support this model, rather than the more detailed Bakos and Treacy model, it will be used for the remaining analysis.

Four questions were included in the metric to collect information about the type of information systems department each company operated, whether the organization developed applications or purchased off-the-shelf software, and whether management considered competitive advantage when they evaluated potential applications. These questions were hypothesized to represent the factor called *Development Characteristics*. Factor analysis was performed on these questions measure their validity. Table 8 shows the predicted and actual correlations between these questions.

Table 8: Correlation Matrix for Development Characteristic Questions

Question				
	2	10	26	28
2		45.1	39.6	27.5
10	52		59.04	41
26	29	64		36
28	32	30	42	
DevChar	55	82	72	50

Where DevChar = Development Characteristics

The lower triangle of this chart shows the actual correlations between the indicators multiplied by 100. The upper triangles show the predicted correlations multiplied by 100.

Predicted correlations are calculated as $r_{ij} = r_{iF_i} * r_{jF_j}$. There are no significant differences between predicted and actual correlations.

The row is the factor loadings for the development characteristics factor.

Spearman Brown's Standard Score Coefficient Alpha for *Development Characteristics* is 0.739.

The factor questions were also tested for unidimensionality and parallelism. The factor was determined to be both, so responses to these questions may be summed to create a *Development Characteristics* measure.

5.2.1.2 Factor Analysis of the User Satisfaction Metric

To measure *User Satisfaction (US)*, the four question metric from Seddon and Yip (1992) was included in the *Competitive Advantage* survey that was completed by the executives participating in this study. In addition, all of the staff employees that were interviewed during the site visits completed a one-page survey that consisted only of these questions (Appendix C). In total, *US* data were gathered from 86 people, 31 staff members and 55 executives. The staff members performed various functions including

accounts receivable, accounts payable, customer service, order entry, billing, staff purchasing, and production supervising.

Confirmatory factor analysis was used to determine if the four questions included in the survey were a reliable measure of *User Satisfaction*. Table 9 shows the correlation matrix for these factors. The lower portion of the matrix shows the actual correlations between the questions, and the upper portion shows the predicted correlations. None of the errors between predicted and actual correlations were significantly different from zero.

Table 9: Expected and Actual Correlations between User Satisfaction Questions

Questions:		1	2	3	4
	1		83.6	91.2	52.25
	2	83		84.5	48.4
	3	90	87		52.8
	4	55	48	52	
Factor Loading:	User Satisfaction	95	88	96	55

The lower portion of the correlation matrix shows the actual correlation between question responses * 100.

The upper portion of this matrix shows the predicted correlation between question responses * 100. There are no significant errors.

There are two different tests for unidimensionality. The first one tests if the factors not only are correlated with each other similarly, but that they represent the factor with the same “quality” or strength. The second one relaxes the quality constraint to allow the quality of the factors to vary. The combined test for a unidimensional factor that had all items of equal quality was rejected for this factor. This failure was the result of question four which was reversed coded and asked if the respondent was dissatisfied or

satisfied with the system. After the author received several surveys with inconsistent responses to the last question, she asked a number of respondents why they had completed the questionnaire as they had. They all admitted that they had not read the question carefully and had made a mistake. If the parallelism test was modified to allow the quality of the items to vary, then the data supported the model that there was one factor being represented by these four questions. In addition, the Spearman Brown's Standard Score Coefficient Alpha that measures the factor's reliability was 0.90. This is similar to the reliability factors published in earlier research using this survey. Therefore, the four questions will be summed to create a *User Satisfaction* index.

5.2.2 Hypothesis Testing and Results

5.2.2.1 Hypothesis One: Test of the Bakos and Treacy Model

While the original Hypothesis One predicted that the factors of *Bargaining Power*, *Switching Costs*, *Internal Efficiency*, and *Interorganizational Efficiency* would lead to *Competitive Advantage*, confirmatory factor analysis revealed only two distinct factors from the survey responses: *Administrative Strategies* and *Interorganizational Strategies*. Therefore, the first hypothesis must be restated as *Administrative Strategies* and *Interorganizational Strategies* will lead to *Competitive Advantage*.

To test this hypothesis, each individual's survey response was used to calculate an index for each of the constructs in the hypothesis. The responses from the ten questions that were indicators of *Interorganizational Strategies* were summed to create an *Interorganizational Strategy* index. Similarly, the two questions of *Administrative*

Strategies and the three questions of *Competitive Advantage* were summed to form their index values.

These index values were used in a linear regression analysis of the following equation:

$$CA = \alpha + \beta_1 IS + \beta_2 AS + \varepsilon$$

where

CA = *Competitive Advantage*,
IS = *Interorganizational Strategies*, and
AS = *Administrative Strategies*

Both factors are hypothesized to be positively related to *Competitive Advantage*. Table 10 shows the results.

Table 10: Linear Regression Analysis of Factors Leading to Competitive Advantage

<i>Regression Statistics</i>	
Multiple R	0.713637
R Square	0.509278
Adjusted R Square	0.490405
Standard Error	3.43196
Observations	55

<i>ANOVA</i>					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	2	635.635	317.8175	26.9832	9.16E-09
Residual	52	612.474	11.77835		
Total	54	1248.109			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	-7.52484	2.683061	-2.80457	0.007069
IOS	0.343696	0.051373	6.69023	1.54E-08
AS	0.337281	0.147918	2.280184	0.026726

Where:

IOS = Interorganizational Strategies
AS = Administrative Strategies

As Table 10 shows, the coefficients for both of the strategies for *Competitive Advantage* were positive and significant, which support the modified causal model for *Competitive Advantage*. In addition, the overall model has an Adjusted R^2 value of 0.49, and the ANOVA results show an F score that is significant at less than 1%. All of these measures support hypothesis one. They also provide some evidence that the strategies proposed by Bakos and Treacy are seen by managers as methods to use computer systems to gain competitive advantage.

If the *Development Characteristics* factor is added to the model, it is hypothesized that firms with the higher development score, i.e. those that create their own applications considering *Competitive Advantage* during application design, will have higher perceptions of *Competitive Advantage* from their computer systems. Table 11 shows the regression results when the measure of *Development Characteristics* is added.

Although *Interorganizational Strategies* is still a more important predictor of *Competitive Advantage* than *Administrative Strategies*, *Development Characteristics* is now the only significant cause of *Competitive Advantage*. However, the Adjusted R Square statistic has decreased showing that the overall predictability of this model is lower than the previous one.

These results provide some evidence that the firms that perceive they are enjoying *Competitive Advantage* are those that manage their computer systems to achieve such advantages. However, it is not possible to determine if manager's perceptions are influenced because they feel ownership for the information systems, or whether they are actually enjoying a *Competitive Advantage*. Future research should be performed to

determine whether manager's perceptions are accurate measures of *Competitive Advantage*.

Table 11: Competitive Advantage Linear Regression with Development Characteristics

<i>Regression Statistics</i>	
Multiple R	0.639
R Square	0.409
Adjusted R Square	0.374
Standard Error	3.803
Observations	55

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Sig F</i>
Regression	3	510.624	170.208	11.771	5.66E-06
Residual	51	737.485	14.460		
Total	54	1248.109			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	-3.94	4.256	-0.927	0.358
External	0.096	0.066	1.448	0.154
Internal	0.126	0.108	1.167	0.249
DevChar	0.388	0.131	2.969	0.005

Where:

IOS = Interorganizational Strategies

AS = Administrative Strategies

DevChar = Development Characteristics

5.2.2.2 Hypothesis Two: REA Systems Provide Competitive Advantage

Since the data from the *Competitive Advantage* survey have been shown to be reliable, they are used as the foundation for testing Hypothesis Two, a prediction that *Accounting System Classification* will affect *Competitive Advantage*. Specifically, the

hypothesis is that the firms using systems more like REA systems will enjoy more competitive advantage than firms that have more traditional systems.

To test this hypothesis, average index values are calculated for each firm. The *Accounting System Classification (ASC)* score is calculated from the *ASC* questionnaire completed during the site visits. This score has two components. First, each firm's computer system is analyzed to determine if the key events are supported. Second, system users are questioned about the information they use to perform their daily tasks and where they get this information. These questions are scored to determine how the system meets the user's needs. All of the user scores are averaged to determine the average organizational score for the firm. To weigh the organization and system scores similarly, the average organization score is multiplied by ten; the result is summed with the system score to calculate the firm's *ASC* score.

Each firm had several executives complete the *Competitive Advantage* questionnaire, and the responses to three of the question were summed to create an individual *Competitive Advantage* index used to test Hypothesis One. For this analysis, the responses from the executives of each firm were averaged to create a firm-level *Competitive Advantage* index. These responses had to be averaged, rather than summed, because there were not the same number of responses for each firm; one firm had only three executives who participated while the maximum number of participants was nine.

To test Hypothesis Two, the firm-level *Competitive Advantage* index was correlated with *ASC*. Lower scores on the *Competitive Advantage* index meant that the executives believed more strongly that their system provided competitive advantage, and

higher *ASC* scores represented more advanced systems. Therefore, the correlation between the two is hypothesized to be negative.

Table 12 shows the resulting correlation matrix that includes the three factors from Hypothesis One and the *ASC* score. As shown, the correlation between *ASC* and *Competitive Advantage* is negative, as predicted, but is not significant. However, *ASC* is significantly negatively correlated with *Administrative Strategies*. Therefore, this provides some evidence for the model posed at the end of Chapter 3 as Research Question 1.

Table 12

Correlation Matrix of Competitive Advantage Factors and *ASC* Scores

	<i>CA</i>	<i>External</i>	<i>Admin</i>	<i>ASC</i>
CA	1			
External	0.874894	1		
Admin	0.533935	0.253506	1	
ASC	-0.08044	0.250778	-0.54917	1

Where

CA = Competitive Advantage

External = External Strategies

Admin = Administrative Strategies

ASC = Accounting System Classification Score

5.2.2.3 Research Question 1: REA Systems Indirectly Provide Competitive Advantage

To further evaluate the model presented as RQ1, path analysis was performed on the firm level data. The first model tested is shown in Figure 8. This model predicts that *ASC* is an antecedent factor of the *Administrative Strategies (AS)* and *Interorganizational Strategies (IOS)* constructs, which are both antecedent factors of *Competitive Advantage (CA)*. Higher *ASC* scores represent more advanced systems, while lower scores for other

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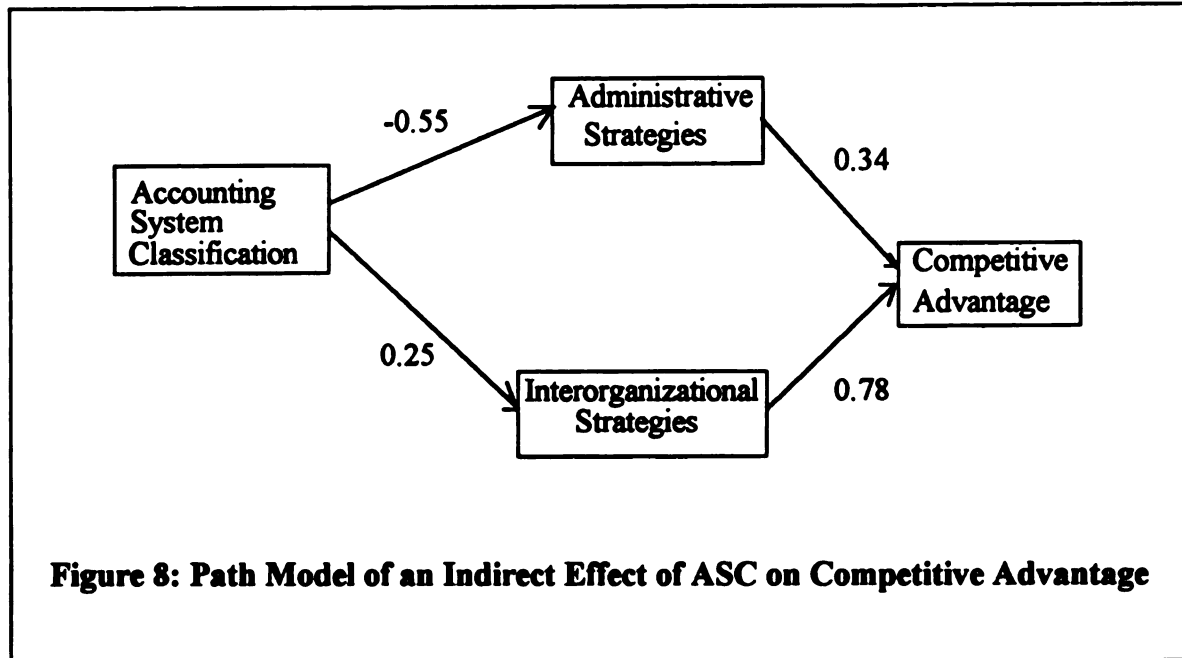
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factors represent stronger perceptions of each specific advantage from the computer systems. As such, the link between *ASC* and *AS*, and the link between *ASC* and *IS* are both predicted to be negative. The links to *CA* are both predicted to be positive.

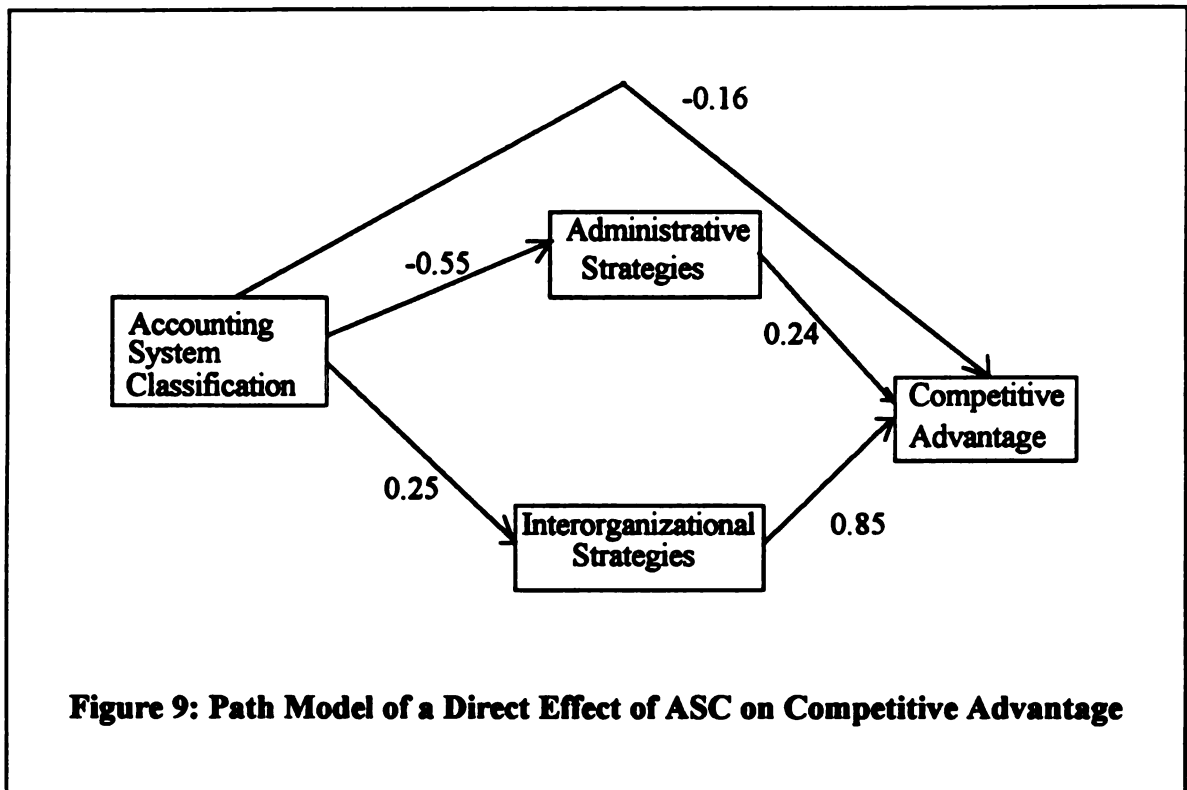


Using the Spearman Brown's Standard Score Coefficient Alpha scores as the reliabilities for the factors from the Competitive Advantage survey, this model was tested using path analysis. The resulting path coefficients are shown in Figure 8. As predicted, the link between *ASC* and *AS* is negative; however, the link between *ASC* and *IS* is positive. Both of the links to *CA* are positive, as predicted. In addition, the overall Chi square value for the model is 0.41, which has a tail probability of 0.814. Therefore, the data fails to reject the hypothesized path model.

These results provide evidence that more advanced systems do provide a means for the firms to gain administrative efficiencies. However, the main way that executives

perceive their systems as providing competitive advantage is through the implementation of *Interorganizational Strategies*. Higher *ASC* scores were actually indicative of firms that believed their system provided *fewer* benefits from these strategies.

A second model was tested to determine if *ASC* also had a direct effect on manager's perceptions of competitive advantage. This model is illustrated in Figure 9.



The path coefficients are also shown on this figure. The links that were in the previous model have changed very little. The new link between *ASC* and *Competitive Advantage* is negative, as predicted, but is relatively small. The Chi Square score for this model is 0.39, which again shows that the data fail to reject this model. This provides

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limited evidence that *ASC* has a direct effect on *CA*, but it is not large. Again, the major contribution from more advanced systems appears to be in improved *Administrative Strategies*, rather than in *Competitive Advantage*.

5.2.2.4 Hypothesis Three: REA Systems Lead to Operational Improvements

Several measures are used to provide evidence about productivity and efficiency in the organizations that participated in this study. As discussed in section 4.2.3, productivity should be measured as the number of units of output produced divided by the number of units of input. In this study, the definition is further restricted to represent a ratio of outputs:inputs at a corporate level. Segmented data, such as volume of a specific activity, are defined as measures of efficiency.

To collect efficiency and productivity data, the contact person from each firm completed an introductory questionnaire (Appendix D). This questionnaire asked for information about each firm's sales volumes, the number of invoices they sent, and the number of checks written in recent years. In addition, the contact person was asked to provide the number of units of product produced, and the unit of measure used by the firm. The expectation was that these figures could be used to measure efficiency and productivity, respectively. Table 13 shows summary demographic statistics that were collected from the firms in this sample.

Table 13: Demographic Statistics

Demographics	<u>Mean</u>	<u>Min</u>	<u>Max</u>	<u>Standard Deviation</u>	<u>Count</u>
Operational Statistics					
Customer Orders	11,000	1,000	28,000	9,340	8
Invoices	19,800	1,800	56,900	17,620	8
Purchase Orders	3,400	500	6,000	2,070	6
Checks Written	7,300	2,200	17,200	5,630	8
Employee Statistics					
Number of Employees	190	40	450	130	8
Number of White Collar Employees	40	3	170	50	8
Number of A/P Employees	1	1	3	1	8
Number of A/R Employees	1	1	3	1	8
Number of Customer Service Employees	7	2	20	6	8
Number of Employee Hours	335,700	62,000	950,300	316,390	7
Number of White Collar Hours	96,400	7,800	397,800	129,260	8
Accounting & Finance Wages	\$181,400	\$40,000	\$500,000	\$154,880	7
Customer Service Wages	\$147,300	\$43,300	\$233,500	\$86,430	6
Factory Wages	\$4,241,400	\$200,000	\$15,156,700	\$5,212,410	7
Total A&G Wages	\$1,356,500	\$120,000	\$5,273,000	\$1,944,170	6
MIS Expenses					
Hardware/Software	\$83,800	\$4,850	\$382,000	\$134,700	7
Payroll	\$41,300	\$0	\$194,000	\$75,810	6
Supplies	\$72,600	\$1,000	\$417,400	\$169,000	6
Other	\$35,700	\$3,500	\$160,000	\$69,470	5
Total	\$206,900	\$14,800	\$1,153,400	\$418,230	7

5.2.2.4.1 Productivity Improvements

Although all of the firms in this sample are in the paper industry, their production measures varied considerably. Some firms were unable to identify a unit of measure or a production quantity that they felt would provide any insight into their organization. These

companies produce very customized products; in effect, each production run is unique, and the number of units produced on one run cannot be compared to those of any other run.

In most other cases, the measure used by the firm was selected to help them manage their operations, and to align incentives with corporate goals. For example, one firm measured production by the number of hours that the equipment ran. While this may seem to be a poor measure of productivity, their reasons behind it were rational. This company also produces customized products, so comparing the physical units is not meaningful. In addition, they have invested in several expensive, customized pieces of equipment that are currently running below 75% of capacity. At this time, their main strategy to improve profitability is to generate more customer orders and to use the additional capacity available on the existing equipment. Because they have very accurate machine usage statistics, this appears to be a good way for them to measure the production volumes for their organization.

For this study, the number of units of output will have to be measured by the sales dollars of the firm. Although this is frequently cited as a problem with productivity work, there is no other common measure of output available to compare the eight firms. In addition, this is an output measure used by at least one firm whose manager was unable to identify a single unit of output for their firm. Instead, he calculated their units of production by dividing sales by the average unit cost for the goods they produced. By using this measure, they were able to provide a production figure to managers even though they produced customized products in small batch sizes.

Several measures of inputs are used to calculate productivity. First, the number of employee hours was provided by the firms. In addition, the number of white collar hours was also available from the firms. Finally, the amount of wage expense is another measure of the inputs into the production process.

To determine if firms that used systems that were more similar to REA systems were more productive, correlations between the productivity figures and the *ASC* score were calculated. As shown in Table 14, when the complete sample is included in the analysis, none of the productivity measures are significantly correlated with *ASC*. However, when a scatter plot of the data was analyzed for outliers, one organization appeared to be driving the results. This company has the least complex operating environment and has the lowest *ASC* score. It was determined that this company may be significantly different from the others, so it was removed from the population. The correlations were recalculated (Table 15). In this case *ASC* is positively correlated with the number of employee hours incurred in the previous year. However, there is a negative correlation between the *ASC* score and the productivity figures that are calculated using wage expense figures rather than hours. Therefore, if productivity is calculated using units of inputs, the data is consistent with the hypothesis that systems more like REA systems provide productivity benefits. However, if costs of the inputs are factored into the equation, systems that are more similar to traditional systems appear to lead to improvements in productivity. It appears that the companies that use more sophisticated computer systems also pay their employees higher salaries.

Table 14: Correlations between Productivity Measures and ASC Score

	<i>ASC</i>	<i>Sales/ Emp Hour</i>	<i>Sales/ WC Hour</i>	<i>Sales/Total Wages</i>	<i>Sales/ A&G\$</i>
ASC	1				
Sales/Emp Hour	0.074	1			
Sales/WC Hour	0.042	0.609 *	1		
Sales/Total Wages	-0.299	0.116	-0.155	1	
Sales/A&G\$	-0.099	-0.152	-0.186	0.932	1

* Using t-test of Pearson Product Correlation, $p < 0.05$

Table 15: Correlations between Productivity Measures and ASC Score Removing Outlier

	<i>ASC</i>	<i>Sales/Emp Hour</i>	<i>Sales/WC Hour</i>	<i>Sales/Total Wages</i>	<i>Sales/ A&G\$</i>
ASC	1.000				
Sales/Emp Hour	0.556 *	1.000			
Sales/WC Hour	0.046	0.577 *	1.000		
Sales/Total Wages	-0.520	0.239	-0.159	1.000	
Sales/A&G\$	-0.443	0.056	-0.208	0.948 **	1.000

* Using t-test of Pearson Product Correlation, $p < 0.10$

** Using t-test of Pearson Product Correlation, $p < 0.05$

5.2.2.4.2 Efficiency Improvements

Because it is difficult to isolate a computer system's influence on overall measures such as productivity statistics, it is often important to analyze more disaggregate statistics such as efficiency measures. Using this analysis, it may be possible to identify specific effects of the system, and to explain how the system affects the organization (Sethi and King 1994). There are several measures of efficiency that can be used to compare the firms in this study. First, operational statistics provided by the firms can be used to calculate the following efficiency measures:

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- Customer Orders/# of Customer Service Employees
- Customer Invoices/# of Customer Service Employees
- Customer Invoices/# of Accounts Receivable Employees
- Checks Written/# of Accounts Payable Employees

Another measure that may proxy for efficiencies arising from the computer system is the *User Satisfaction (US)* index. As discussed, this index is compiled from user responses to questions about the computer system's effect on user efficiency and effectiveness. If this measure is correlated with the *ASC*, then more sophisticated systems are correlated at least with user's perceptions of their efficiencies.

Correlations between these measures and the firm's *ASC* score are calculated and reported in Table 16. This table shows that the only significant correlation between *ASC* score and an efficiency measure is with Checks per A/P Clerk. It is possible that the three-way match process has been automated (or reengineered) in the firms with more sophisticated systems. Therefore, the firm's Accounts Payable department is able to process more vendor invoices with fewer clerks.

The correlation between Customer Orders per Customer Service Employee is insignificant when all of the firms are included in the analysis. However, upon inspection of the data, it appears that one firm may have had an error in the number of orders and invoices they reported. They wrote that they received fewer than 2,000 customer orders in 1994, but prepared over 50,000 customer invoices. It seems unlikely, given the nature of their business, that they produce 25 invoices from each order. If this firm is removed from the analysis, the correlation between Customer Orders per Customer Service Employee and *ASC* score is 0.58. While insignificant, this correlation is in the positive

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direction and provides some evidence that the other firms appear to be enjoying an efficiency improvement with the introduction of more sophisticated systems.

Table 16: Correlations between ASC Scores and Measures of Efficiency

	<i>ASC</i>	<i>CO/ #CSEmp</i>	<i>Inv/ #CSEmp</i>	<i>Inv/ AR</i>	<i>Chk/ AP</i>	<i>UserSat</i>
<i>ASC</i>	1					
<i>CO/#CSEmp</i>	-0.018	1				
<i>Inv/#CSEmp</i>	-0.061	0.709 *	1			
<i>Inv/AR</i>	0.251	-0.108	0.296	1		
<i>Chk/AP</i>	0.512 **	0.241	-0.051	0.188	1	
<i>UserSat</i>	-0.249	-0.547 **	-0.256	0.227	-0.489	1

Where:

ASC = Accounting Systems Characteristics score

CO/#CSEmp = Customer Orders per Customer Service Employee

Inv/#CSEmp = Customer Invoices per Customer Service Employee

Inv/AR = Customer Invoices per A/R Clerk

Chk/AP = Number of Checks Written per A/P Clerk

UserSat = Summary measure of user satisfaction

* Using a t-test of the Pearson Product correlation, $p < 0.05$

** Using a t-test of the Pearson Product correlation, $p < 0.10$

5.3 Discussion of Results

This chapter provides several measures of the benefits provided from information systems, focusing on incremental benefits from systems more like REA accounting information systems than more traditional systems. By examining eight firms in detail, it was possible to become familiar with their operational environments and the demands placed upon their systems. In addition, statistical analysis was performed to provide analysis of three hypotheses that had been developed earlier in this dissertation.

The qualitative analysis relied heavily on information gathered during the site visits. In all cases, the users throughout the organization were interviewed. They were

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asked to evaluate their current system and to make recommendations for enhancements. It was through these discussions that the researcher was able to identify key systems characteristics that would provide solutions for the problems that the firms in this study were experiencing. As such, the key characteristics were often the enhancements that systems users recommended, believing that these changes would improve either their efficiency or effectiveness. This analysis and the list of key characteristics provides evidence that not all systems provide benefits to their users; rather systems that have specific characteristics will be more beneficial to organizations.

The field study methodology also allowed the researcher to identify situations in which systems characteristics and organizational characteristics would interact and influence the amount of benefits that the system could provide. Again, these insights can be used to identify organizations that may benefit from more advanced systems and those that will not require the expenditures.

These findings can be used to explain some of the interesting quantitative results. The Bakos and Treacy model was modified so only two different strategies were predicted to result in competitive advantage: *Administrative Strategies* and *Interorganizational Strategies*. The data from the CA survey supported the hypothesis that executives of firms that used their systems for either of these strategies believed that their systems provided their firm with competitive advantage. Therefore, there is evidence that these executives do perceive their system as providing competitive advantage.

However, when the model was expanded to include the accounting information system, the results showed that systems more like REA were being used to improve the

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firm's administrative efficiencies, but they were not being used to implement interorganizational strategies. This is an important finding as it was the interorganizational strategies that were the main cause of competitive advantage from information technology.

These puzzling results may be explained through insights provided during the site visits and the interviews with the executives. One explanation is that the executives who had more sophisticated systems were also more sophisticated in their knowledge of information systems. It was common for these executives to understand the current technology available, and to be critical of their systems that they believed to be out of date. Therefore, these executives may have perceived their systems as providing less competitive advantage than they desired, and their *CA* scores would be lower.

These results may also arise because the smaller firms are the ones that have been forced to implement systems to meet their customers needs. For example, one firm had a personal computer devoted to EDI processing of large customer orders. While they believed that this system provided them some benefits, it would have had a negative impact on their *ASC* score since this personal computer is not integrated with the firm's main system. As a result, several redundant processes were necessary to record the orders and to distribute the electronic customer invoices. In addition, several spreadsheets were maintained to capture the information in the orders.

A final explanation is that the bulk of the energy in information systems advancement has been to automate the administrative functions such as accounts payable and order processing (improvements in both were correlated with higher *ASC* scores).

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Practitioners have not yet devoted the time necessary to produce systems that meet the other user's needs. In this sample, most of the major systems complaints centered on the production process. In many cases, the users were unhappy with systems that could only perform batch processing of production data or with systems that did not support the production environment at all. Without meeting production needs, it would be difficult for the firms to respond quickly to customer needs or to improve their power over their suppliers. As a result, the path coefficients would accurately reflect the situation within the firms in this sample: their systems are solving some management problems, but have yet to tackle the interorganizational links within the value chain.

The quantitative productivity and efficiency provide some additional evidence that systems more like REA accounting information systems provide more benefits than more traditional systems. The amount of sales per employee and checks per A/P clerk are positively correlated with the firm's *ASC* score. However, sales per labor dollar is negatively correlated with the *ASC* score, and the remaining efficiency variances are insignificantly related to *ASC* score.

Overall, the research approach used in this study has provided detailed insights into companies in the pulp and paper industries. The qualitative and quantitative analysis techniques have provided evidence of benefits from systems more like REA systems. The interviews with a wide variety of employees provide a more complete view of each organization and its system than a survey or archival study would have gathered. In addition, the quantitative results support the hypotheses that firms use information technology to gain competitive advantage and improvements in productivity and efficiency.

Chapter 6 - Contributions and Suggestions for Future Research

6.1 Contributions

This dissertation makes four major contributions to the accounting information systems literature. First, it presents a questionnaire that can be used to evaluate systems along the continuum between traditional and REA accounting information systems. Second, it uses qualitative information collected from eight organizations to develop a more precise operational definition of REA accounting information systems. Third, it presents a survey that captures manager's perceptions of competitive advantage and results that show accounting information systems as providing such an advantage. This is especially true if they are able to assist management in implementing interorganizational strategies. Finally, evidence is provided that the type of accounting information system used will influence an organization's productivity and efficiency. The following sections discuss each of these in more detail.

6.1.1 Accounting Systems Characteristics Metric

Except for Weber (1986) and Andros et al. (1992), the research in REA accounting information systems has been theoretical and normative. This study is, therefore, one of the first to evaluate information systems and provide evidence about the benefits of more sophisticated systems. One of the major difficulties in attempting this study was that there was no operational definition of REA accounting information systems. Weber (1986) had focused only on the revenue cycle and he had studied vendor documentation to gain an in-depth understanding of the data storage structure of these firms. The goal of this study was to understand how the systems were being used in live

firms, and how organizational characteristics influenced the manner in which the systems were used. Therefore, it was not possible to focus on only the data.

The first step in this project was to develop the *Accounting System Characteristics* questionnaire. This questionnaire was developed to gather high level information about each system's data, how the data were processed, and how the users were able to function with the system. The questions included in the survey were designed to capture qualities of REA and traditional systems, so that the overall score an organization received would place them along the continuum between the two poles. Through pilot testing and use in this study, it appears this metric successfully ranks the systems evaluated. Therefore, it could be used in future research as a method of gathering specific information about organizations and their accounting information systems.

This metric also may provide benefits to practitioners. The accounting firm that participated in the pilot study is very interested in using the metric to gain a thorough understanding of potential client's systems quickly. In addition, the companies that participated in this study perceived their completed study materials (often 25-30 pages long) as valuable. They believed that the list of potential enhancements could be used management to prioritize new systems requirements. They felt that the descriptions of the process employees performed were valuable if consultants were to come to the organizations. Management planned on having the consultants read the *ASC* questionnaire before they performed any interviews with the hope of minimizing the consultant's time and, therefore, fees.

6.1.2 Operational Definition of REA Accounting Systems

Although the *ASC* questionnaire was developed using the theoretical tenets of REA, the accounting literature has not included a detailed definition of how to operationalize an REA system. However, by using a consistent questionnaire at each of the organizations, this study presents results of comparing and contrasting the systems and their effects on the organizations. Using this information, it was possible to identify the key characteristics that move a system along the continuum between traditional and REA systems.

This definition could be used to categorize prior research of systems benefits by identifying which systems characteristics have provided benefits to firms. For example, Mia and Chenall (1994) studied the relationship between manager performance and the use of broad management information systems (MIS). Their definition of a broad MIS is one that supports several sites and provides non-financial information about several key business processes, and the data are not aggregated. These systems also provided timely information and supported management decision models. These systems would be closer to REA systems than to traditional accounting because they support the key processes, they maintain detailed histories, and managers are able to retrieve information to meet their needs. To measure manager performance, they asked the participants' supervisors to rate their performance. Analysis of five firms in different industries that used broad MIS demonstrated that system use was correlated with performance and that the relationship was much stronger for the executives in marketing roles than for those in production. Assuming that the supervisors gave higher ratings to managers that performed their

functions either more efficiently or more effectively, this study provides evidence that systems more similar to REA systems than traditional ones were able to provide improvements in internal efficiencies, especially to the administrative staff. These efficiencies may result in competitive advantage for a firm or increased productivity. Therefore, the results of the Mia and Chenall study are very similar to those from this dissertation.

6.1.3 Competitive Advantage

This study reports the development of a survey that can be used to measure how management's perceptions about their systems and the effect these systems have on the firm's competitive position. Specifically, the Bakos and Treacy (1986) theoretical model of competitive advantage was operationalized as a survey, and the survey was distributed to several executives in each organization to collect a well-rounded view of the systems.

Through confirmatory factor analysis, it was determined that the managers in this sample were using two distinct strategies to gain benefits from their systems: they used their systems to improve operational efficiency and they used them to improve interorganizational relationships with customers and suppliers. Using these insights, it was determined that the interorganizational strategies that were supported by the information systems were more strongly linked with competitive advantage from systems. In addition, the systems that were more like REA systems were used to improve administrative efficiencies but not interorganizational efficiencies.

6.1.4 Efficiency and Productivity

The quantitative analysis provided evidence that the more advanced systems did provide benefits to firms using them. Overall productivity improved if it is measured in terms of the sales generated per labor hour. However, other productivity measures, such as the number of units of output by the number of units of input, were not possible to calculate. Even though the firms in this study were in the same industry, they produced a wide range of products, and often produced a different custom good with each production run. Therefore, summing the number of units produced would not provide a meaningful statistic.

Because of difficulties in measuring productivity and identifying the link between the information systems and productivity, efficiency measures were also calculated. By comparing them with the type of system the organization used, it was determined that efficiency improved for accounts payable clerks and customer service clerks in organizations that used systems more like REA systems. Other measures of efficiency, however, were not found to be significantly affected by the type of system used.

6.2 Future Research

There are many opportunities to continue this line of research. This study is one of the first empirical analyses of REA systems, and, although it provides some evidence of the effects these systems have on organizations, it has several weaknesses that must be addressed in future research. The following section identifies some of these weaknesses and makes recommendations for how they may be overcome in the future.

First, it would be beneficial to perform a longitudinal study to determine how a new REA system will affect an organization. This research design would control for the organizational characteristics that make comparing the benefits from systems across organizations. In a longitudinal study, many of these characteristics would remain constant. Therefore, productivity and efficiency figures could be calculated for operations under the old and new systems, and the results compared. Then the changes could be attributed to the new system.

Second, future research should involve directed REA designs and implementations. Unfortunately, none of the firms in this sample have participated in such a design. Therefore, it is difficult to make claims about benefits that would accrue to those who implemented systems with the most advanced REA characteristics (directed implementation and no journal entries). If these development approaches were included in future research, the costs and benefits of such implementations could be quantified and verified.

Third, organizational characteristics must be included in future studies. For example, complexity should be considered in future studies that evaluate the benefits of REA accounting systems versus traditional accounting systems. Unless the organizations in the study have complex environments, the benefits arising from sophisticated REA systems may not offset the costs necessary to develop and maintain them.

Finally, future research should be performed on larger samples. While it was important to gather detailed insights from organizations for this study, this approach limited the number of companies that could participate. However, now that the key systems and organizational characteristics have been identified, it may be possible to

develop a questionnaire that could be sent to a large number of companies. Results of such a study may be more generalizable to the economy as a whole.

6.3 Conclusions

This dissertation describes a field study experiment that studied the interaction of organizations and their accounting information systems. It presents the first empirical analysis of REA accounting information systems, and includes results that show both qualitative and quantitative analyses of the benefits that arise from them. By nature of the research methodology selected to address these questions, the study provides a detailed operational definition of REA systems, and it challenges future researchers to use this definition in future systems development projects and large sample studies.

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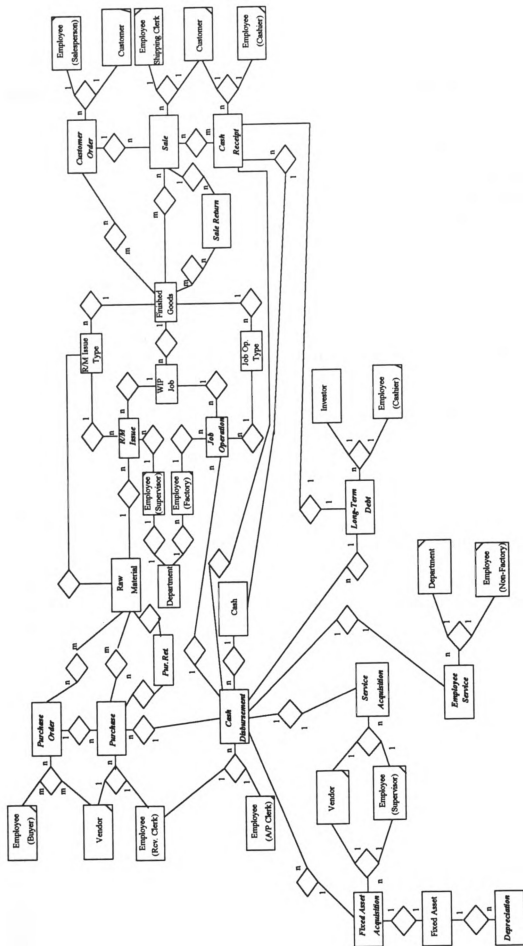
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APPENDICES

APPENDIX A

APPENDIX A: Accounting Systems Characteristics Questionnaire



REA Evaluation Form**System Overview**

1. Use the appropriate, traditional E-R diagram to begin evaluating the system.
 - a. For each event (entities with names written in bold, italic print):
 - i. If not supported by the system, draw an 'X' through the event.
 - ii. If it is supported by the system,
 - * Write the length of time that the records are stored, such as EOD (end of day), EO2Y (end of 2 years), Until Complete Payment.
 - * Write "GL" after the time if the results of the event are automatically posted to the general ledger.
 - b. Identify any business-specific events that are supported by the system
 - i. Draw them on the diagram
 - ii. Identify characteristics as in a.
 - c. For each resource and agent
 - i. Identify any missing from the diagram, and add them
 - ii. Draw an 'X' through any of the traditional ones not supported by the system.
 - d. Relationships
 - i. Draw an "X" through any relationships that are neither explicitly or implicitly implemented in the system.
 - ii. Draw a circle around the relationship if it is implicitly implemented (i.e. it could be 'reconstructed' procedurally).

AS. Scoring:

- A. Add 5 points for each traditional event supported by the system.
- B. Add 5 points for each new event whose data is stored until EOD; 7 points if stored until EOM, and 10 points if stored longer.
- C. Subtract 5 points for each traditional event *with more than 1% of the business' transactions or more than 500 transactions* not supported by the system.

Additional System Questions:

1. How did the organization decide how long to store the events? (+10 if decision included in Events-Driven design)

2. If you have purchased applications programs, list them here:

3. What programming language(s) is/are used to write the applications?

4. How are the explicit relationships implemented?

 Pointers

 Data Base

 Repeating groups

 Physically contiguous

5. If someone wanted information from every cycle, how many terminals would be needed? _____ (-5 for each over 1)

How many times would they have to log in? _____ (-2 for each over 1)

6. Describe your hardware environment (including any client/server configurations).

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Accounting/General Ledger

1. How are your financial statements generated? (Check appropriate)

_____ Chart of Accounts used to prepare General Ledger and Statements **(-5 points)**

_____ No Chart of Accounts. Separate view of the data **(+100 points. This system automatically counts as an Events-Driven system, but continue with survey to record characteristics and implementation decisions made.)**

2. List the manual journal entries entered into the system.

(-10 points for each event)

3. Is information from the Chart of Accounts down-loaded to personal computers where it is manipulated to generate additional reports used by management?

_____ Yes **(-10 points)** _____ No **(0 points)**

Who has requested the downloaded data?

For what purpose?

4. Are G/L account balances transferred from one system to another General Ledger system in the organization? (either manually or automatically)

_____ Yes **(-10 points)** _____ No **(0 points)**

5. How many days after the last day of the months usually pass before the final financial statements can be prepared?

_____ Days **(-1 point per day)**

6. How many codes are embedded in each g/l account number? For example, the account number 01-573-01 that represents division 01, sales manager 5, salesperson 73, sales (01) has 4 codes.

_____ codes **(-2 points per code)**

MIS Characteristics

1. Is the current system the result of a "re-engineering" exercise?

_____ Yes (+10) _____ No (-10 points)

If so, describe 2 major changes that occurred as a result:

a.

b.

(Score 10 points for each change that shows evaluation of business events)

2. Are users *outside of MIS* able to generate ad hoc queries of data in the system (excluding g/l queries)?

_____ Yes (+10) _____ No (0 points)

If so, how are these queries supported?

_____ Query program within the system

_____ Add-on query support (such as SQL)

_____ Download data and manipulate on personal computers

_____ Other:

3. How many users use this facility at least once a month?

_____ (+2 for each with a maximum of 10 points)

4. Is there a steering committee to guide the MIS department?

_____ Yes _____ No

If so, list each non-MIS and non-Accounting *active* member of the committee:

(Score 2 points for each functional area represented on the steering committee)

Page Points _____

4. What

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4. What are the 5 most recent systems projects that have been completed?

(Score +10 points for each that supports an already supported event; +20 for adding support for a new event; -10 for supporting the Chart of Accounts; 0 points for fixing program bugs)

5. Are customers able to get information from your system (either on-line or in reports)?

_____ Yes (+10) _____ No

Give examples:

Functional Department: XXX Staff or Manager

Interviewed: _____

Date: _____

Process:

1. What are the three most important sources of information used to guide this department?
Are they available from your system?

Information Source	Available?

(Score +5 for each that is generated by the system but is *not* a result of the Chart of Accounts; -5 for each not generated by the system that could have been included in an Events Based system)

2. Does the system help your department be more productive?

_____ Yes _____ No

If so, describe 3 ways it does:

a.

b.

c.

(Score +5 for each productivity tool that is a result of an events-driven design)

3. What are the two major enhancements you'd like to see made to the system?

a.

b.

4. How often do you use an on-line inquiry to get information about your department?

_____ Never (-5) _____ Daily (+5)

_____ Weekly (+2) _____ > Once per Day (+10)

Summary Sheet

Implemented applications (Chart)	
Other system characteristics (p.1)	
System Total	
Organization characteristics - Accounting	
Organization characteristics - MIS	
Purchasing characteristics	
Production characteristics	
Sales characteristics	
Distribution characteristics	
Organization Total	
Grand Total	

APPENDIX B

APPENDIX B: Competitive Advantage and User Satisfaction Questionnaire

While computer systems can be used for processing daily transactions, they can play other roles in organizations. This survey attempts to assess the ways in which your organization uses your information system as a competitive tool.

Before you begin to answer these questions, please take a minute to think about how your computer systems have significantly altered either your organization's business, or that of your customers or suppliers.

1. Please indicate you much you agree with each of the statements on the following page using the following 1 to 7 scale:

1 = Strongly Agree

2 = Agree

3 = Agree Somewhat

4 = Neutral

5 = Disagree Somewhat

6 = Disagree

7 = Strongly Disagree

- ___ Because of our computer system, customers would incur a cost to switch to another supplier.
- ___ When we develop or purchase new computer applications, we think about how they will help us compete.
- ___ Our computer system helps us control our production costs.
- ___ Our computer system has reduced the time it takes our administrative staff to do their jobs.
- ___ Our computer system enables us to modify our products so customers value them differently than our competitors' products.
- ___ Because of our computer system, we have been able to sell different products than we would be able to without it.
- ___ We use our computer system to communicate with our suppliers.
- ___ Because our customers rely on unique information from our system, they would have to increase their costs if they were to purchase products from another supplier.
- ___ Our computer system helps us control our administrative costs.
- ___ We develop new applications for our computer.
- ___ Our computer system has made it possible to work with more vendors without incurring extra costs.
- ___ Our customers use a unique, proprietary interface to log into our computer to place orders or get information.
- ___ We are able to produce products more quickly because of our computer system.
- ___ The computer system has helped us produce our products at a lower cost.
- ___ Most of the applications we have developed or purchased that make us more efficient are used by everyone in the industry.
- ___ Our computer system has helped us earn a favorable competitive position in our industry.
- ___ Our customers use information from our computer to improve their profitability.
- ___ We rely on our supplier's computer system so we are not able to switch to another suppliers without increasing some of our costs.
- ___ Our computer system has helped us shift our raw material components toward more generic, commodity products.
- ___ Our computer system has not led to any efficiency improvements for our administrative departments.
- ___ Our computer provides our customers with information that makes them more efficient.

1. (Cont.) Please indicate you much you agree with each of the statements on the following page using the following 1 to 7 scale:

1 = Strongly Agree

2 = Agree

3 = Agree Somewhat

4 = Neutral

5 = Disagree Somewhat

6 = Disagree

7 = Strongly Disagree

- ___ Our computer system provides no competitive advantage.
- ___ Because of our computer system, our product is perceived to be different than our competitors' products.
- ___ Our computer system has no impact on our relative position in our industry.
- ___ We use our computer system to communicate with our customers.
- ___ We make very few changes to our computer system or its applications.
- ___ Because of our computer system, we do not rely on our suppliers for information about raw materials.
- ___ We try to manage our information systems with the goal of being the first company to develop or purchase new computer applications that provide competitive advantage.
- ___ Because of our computer system, we no longer have to purchase custom raw materials, but can now use more generic materials.
- ___ Because our competitors can copy our system, we are not able to sustain any competitive advantage from efficiencies that our computer provides.
- ___ Applications we have purchased or developed to improve our efficiencies will probably be adopted by other firms in our industry.
- ___ Because of our computer system, we have more flexibility in the vendors we can purchase inventory and supplies from.
- ___ Our computer system has helped us become less reliant on any individual vendor.
- ___ Our computer system has no direct impact on our customers' businesses.
- ___ Because of our computer system, we are able to use less expensive raw materials in our production process.
- ___ Because of our computer system, we can purchase inventory and supplies more efficiently.

Please CIRCLE the number that best answers the following four questions.

2. How adequately do you feel your accounting information system (AIS) meets the information processing needs of your area of responsibility?

adequate 1 2 3 4 5 6 7 *inadequate*

3. How efficient is your AIS?

efficient 1 2 3 4 5 6 7 *inefficient*

4. How effective is your AIS?

effective 1 2 3 4 5 6 7 *ineffective*

5. Overall, are you satisfied with your AIS?

dissatisfied 1 2 3 4 5 6 7 *satisfied*

6. List the three most important features of your organization that differentiate it from your competitors and provide you with a competitive advantage:

A. _____

B. _____

C. _____

7. Estimate what percent of your competitive advantage arises from your information system.

_____ %

8. Please provide your position in your organization: _____

APPENDIX C

APPENDIX C: User Satisfaction Questionnaire

This brief survey is designed to measure your overall impressions of your Accounting Information System (AIS). After you complete it, we will discuss the system and how it supports your activities in much more detail. Your results will be kept confidential, so please answer these questions honestly.

Please CIRCLE the number that best answers the following four questions.

1. How adequately do you feel your accounting information system (AIS) meets the information processing needs of your area of responsibility?

adequate 1 2 3 4 5 6 7 *inadequate*

2. How efficient is your AIS?

efficient 1 2 3 4 5 6 7 *inefficient*

3. How effective is your AIS?

effective 1 2 3 4 5 6 7 *ineffective*

4. Overall, are you satisfied with your AIS?

dissatisfied 1 2 3 4 5 6 7 *satisfied*

APPENDIX D

APPENDIX D: Systems Analysis Preliminary Information Form

Please answer the following questions to help me prepare for visiting your organization. Thanks a lot!

1. Fiscal Year End: ____/____/____

2. Provide the following operational statistics:

Question	YTD 10/94	1993	1992	1991	1990
Production:					
Unit of Measure					
Units Produced					
Processing:					
Number of Customer Orders Taken					
Number of Invoices					
Number of Purchase Orders					
Number of Checks Written					
Employee Information:					
Number of Employees					
Number of White-collar Employees					
Number of A/P Employees					
Number of A/R Employees					
Number of Customer Service Employees					
Number of Employee Hours					
Number of White-collar Hours					

3. Please provide the following financial statistics:

Question	YTD 10/94	1993	1992	1991	1990
Sales					
Gross Profit					
Net Income					
MIS Expenses:					
Hardware/Software					
Payroll					
Supplies					
Other					
Payroll Expenses:					
Accounting and Finance					
Customer Service					
Factory					
Total Administrative and General					

Please fax this form to 517-432-1101. Thanks again...I'm looking forward to meeting with you!

Julie Smith David
N238 North Business Complex
Michigan State University
East Lansing, MI 48820

517-353-8647 (voice)
517-432-1101 (fax)

APPENDIX E

APPENDIX E: Systems Analysis Tentative Schedule

Company: «Company»

**Contact: «FirstName» «LastName»
Phone Number: «Phone»**

Instructions:

The following sheets describe the systems analysis activities that we will be performing in the near future.

Please examine the schedule, and complete it with the following ideas in mind:

1. Most activities do not have to occur in the order listed. However, I would like to keep the activities on the day I have indicated if at all possible.
2. Please complete the “Beginning Time” and “Ending Time” columns with times so that the participants are aware of their schedule.
3. Please include everyone’s name so I will be familiar with them before I arrive.

If you have any questions about the schedule or completing these forms, please feel free to call me. The best way to reach me is to call (517) 355-7486. If I am out of town at another company, the office will take a message and make sure that I get it.

Once you have completed the schedule and everyone agrees on our game plan, please fax the forms to me at (517) 432-1101.

Thanks a lot! I am really looking forward to meeting with everyone at your organization!

Sincerely, Julie Smith David

Systems Analysis: Tentative Schedule

Company: «Company» Contact: «FirstName» «LastName»
 Phone Number: «Phone»

Day 1: «DateOne»

<u>Beginning Time</u>	<u>Ending Time</u>	<u>Duration</u>	<u>Activity</u>	<u>Participants</u>	<u>Participant Names</u>
		45 min.	Introduction	Information Systems Purchasing Marketing Production Sales Distribution Finance/Accounting	_____ _____ _____ _____ _____ _____
		4 hours	System Documentation	Information Systems	_____ _____
		1 hours	Accounting/ Finance Analysis	Acc/Fin Executive	_____ _____
		30-45 min.	Accounting/ Finance Analysis, cont.	Accounts Receivable	_____ _____
		30-45 min.	Accounting/ Finance Analysis, cont.	Accounts Payable, Inventory Control	_____ _____

Systems Analysis: Tentative Schedule

Company: «Company»

**Contact: «FirstName» «LastName»
Phone Number: «Phone»**

Day 2: «DateTwo»

Beginning Time	Ending Time	Duration	Activity	Participants (and Staff Names)
		1 hour	Executive Purchasing Analysis	Purchasing Executive
		30 min.	Staff Purchasing Analysis	Purchasing staff member:
		1 hour	Executive Marketing/Sales Analysis	Marketing/Sales Executive
		30 min.	Staff-level Customer Service Analysis	Customer Service staff member:
		1 hour	Executive Production Analysis	Production Executive
		30 min.	Staff-level Production Analysis	Production staff member:
		1 hour	Executive Distribution Analysis	Distribution Executive
		30 min.	Staff-level Distribution Analysis	Distribution Staff Member: _____

Systems Analysis: Tentative Schedule

Company: «Company»

**Contact: «FirstName» «LastName»
Phone Number: «Phone»**

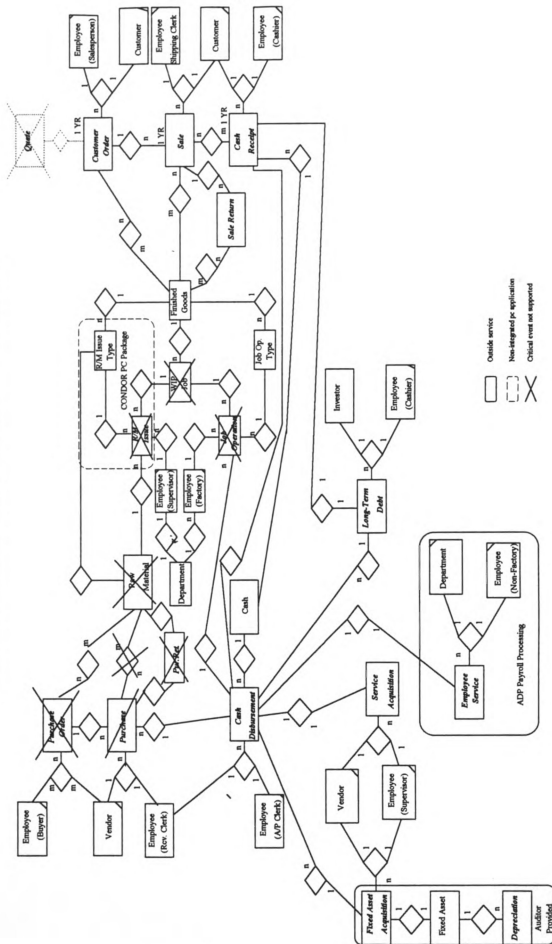
Day 3: «DateThree»

Beginning Time	Ending Time	Duration	Activity	Participants
		3 hours	Seminar on Competitive Uses of Technology, Reengineering and Results of Systems Analysis	Information Systems Purchasing Marketing Production Sales Distribution Finance/Accounting All staff-level participants (if desired)

APPENDIX F

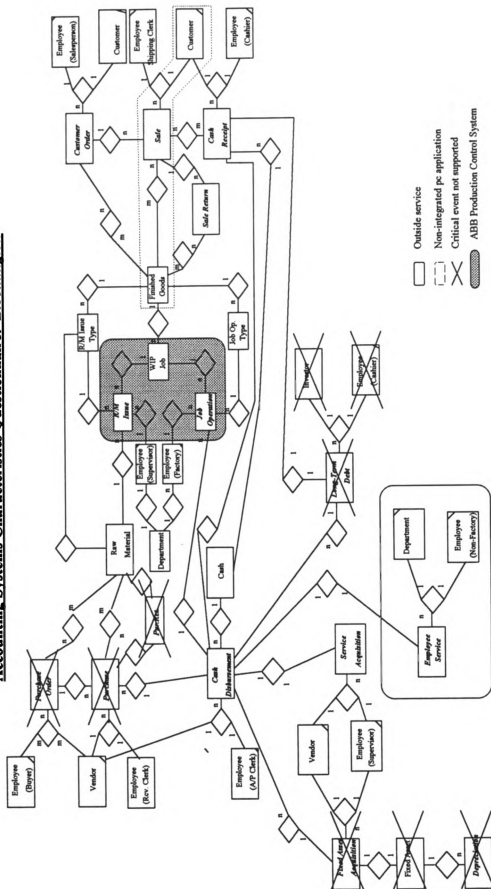
Appendix F: Company REA Diagrams and ASC Summary Sheets

Accounting Systems Characteristics Questionnaire: *Ann Arbor*



Summary Sheet - Ann Arbor

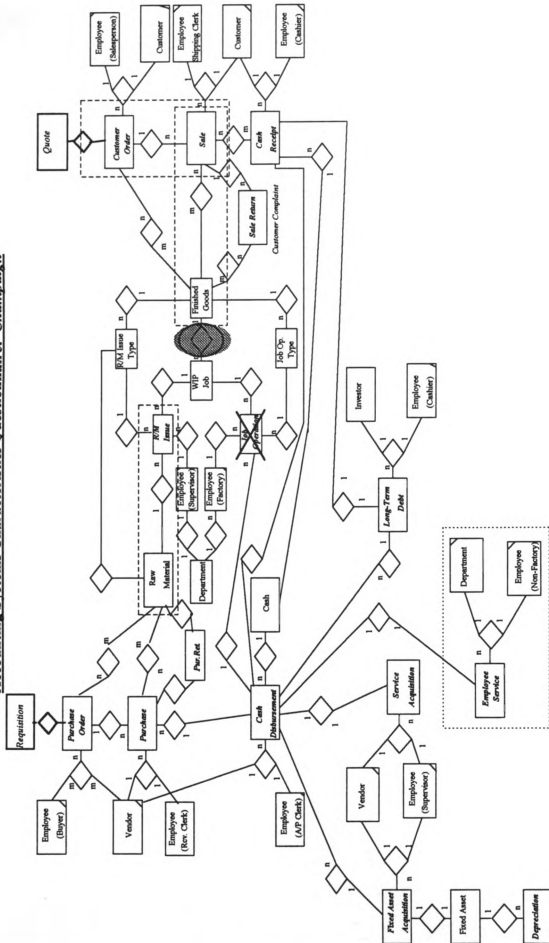
Implemented applications (Chart)	5
Other system characteristics (p.1)	-14
System Total	-9
Organization characteristics - Accounting	-65
Organization characteristics - MIS	0
<i>Department Scores</i>	
Purchasing Executive	0
Estimating Staff	10
Production Executive	7
Production Staff	-10
Sales Executive	-20
Marketing Executive	-10
Customer Service - Custom	10
Customer Service - Gift wrap	20
Accounts Receivable	35
Accounts Payable	25
Average department characteristics	6.7
Organization Total	67
Grand Total	-7



Summary Sheet - Bloomington

Implemented applications (Chart)	10
Other system characteristics (p. 1)	-14
System Total	-4
Organization characteristics - Accounting	-55
Organization characteristics - MIS	12
Purchasing	
Purchasing Staff	
Accounts Receivable	15
Accounts Payable	10
Production	5
Production Staff	-15
Production: Engineering	15
Quality Assurance	30
Scheduling	10
Sales	-5
Sales Staff (Order processing)	20
Distribution	35
Distribution Staff	
Organization Total	77
Grand Total	73

Accounting Systems Characteristics Questionnaire: *Champaign*



Summary Sheet: Champaign

Implemented applications (Chart)	75
Other system characteristics (p.1)	-7
System Total	68
Organization characteristics - Accounting	-57
Organization characteristics - MIS	64
Accounts Receivable	25
Accounts Payable	20
Purchasing Executive	15
Purchasing Staff	25
Sales/Marketing: Eaton	-5
Customer Service	35
Distribution	10
Production	-10
Average department characteristics	14.38
Organization Total	151
Grand Total	219



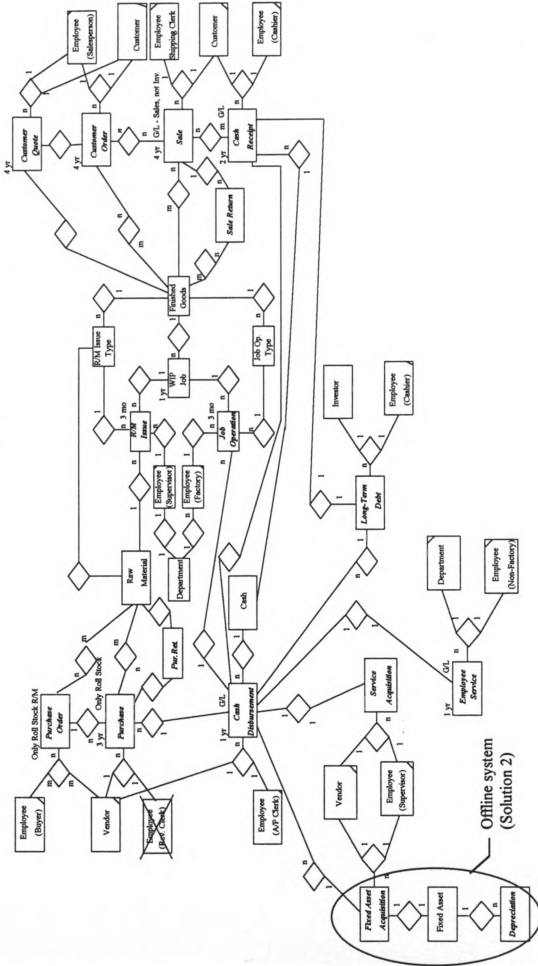
Outside service
Manual process in addition to PeachTree
Personal Computer App.

Summary Sheet: Columbus

Implemented applications (Chart)	40
Other system characteristics (p.1)	-4
System Total	36
Organization characteristics - Accounting	-12
Organization characteristics - MIS	-8
Estimating - boxes	15
Estimating - specialty	-15
Accounts Receivable	5
Accounts Payable	10
Purchasing	0
Partner - Production	-3
Partner - Sales	-10
Distribution	-10
Production	-20
Production - Specialty	-10
Customer Service	-5
Customer Service	0
Average department characteristics	-3.58
Organization Total	-35.8
Grand Total	-20

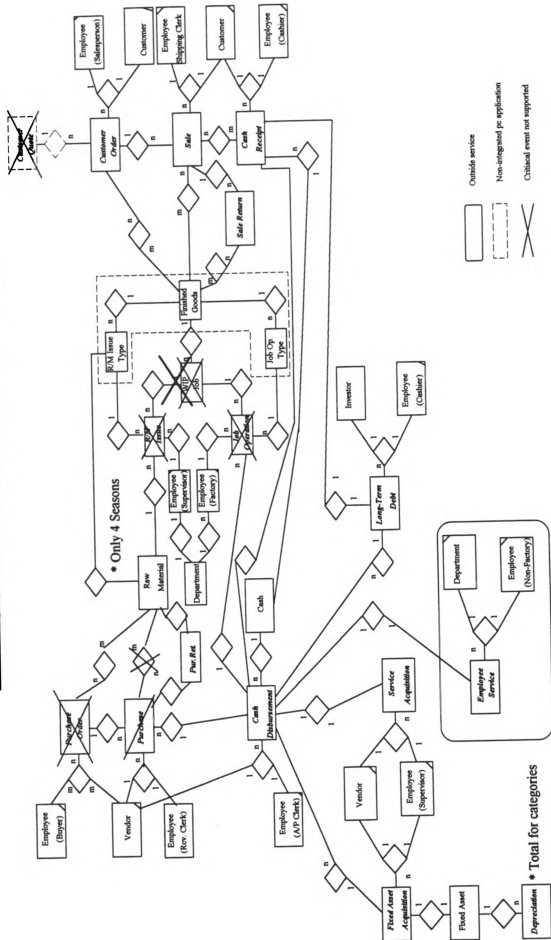
Accounting Systems Characteristics Questionnaire: East Lansing

142



Summary Sheet: East Lansing

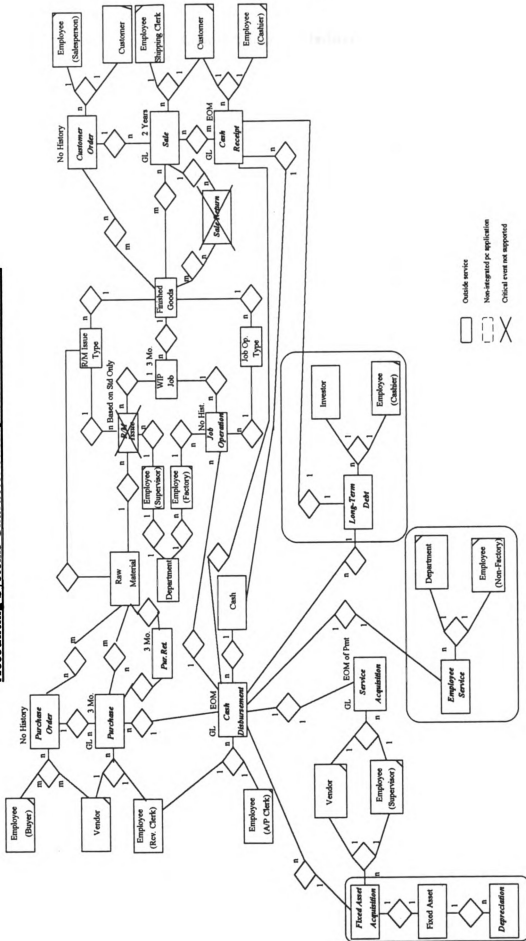
Implemented applications (Chart)	75
Other system characteristics (p.1)	-21
System Total	54
Organization characteristics - Accounting	-44
Organization characteristics - MIS	50
Accounting Executive	25
Billing	30
Accounts Receivable	25
A/P and Production Labor Tracking	20
Operations and MIS Executive	20
Sales and Marketing Executive	10
Purchasing, non roll materials	-20
Customer Service	20
Production/Scheduling Manager	5
Distribution Staff	30
Continuous Improvement Manager	15
Receiving (EDI) Roll Stock	25
Average department characteristics	17.08
Organization Total	171
Grand Total	231



Summary Sheet: Evanston

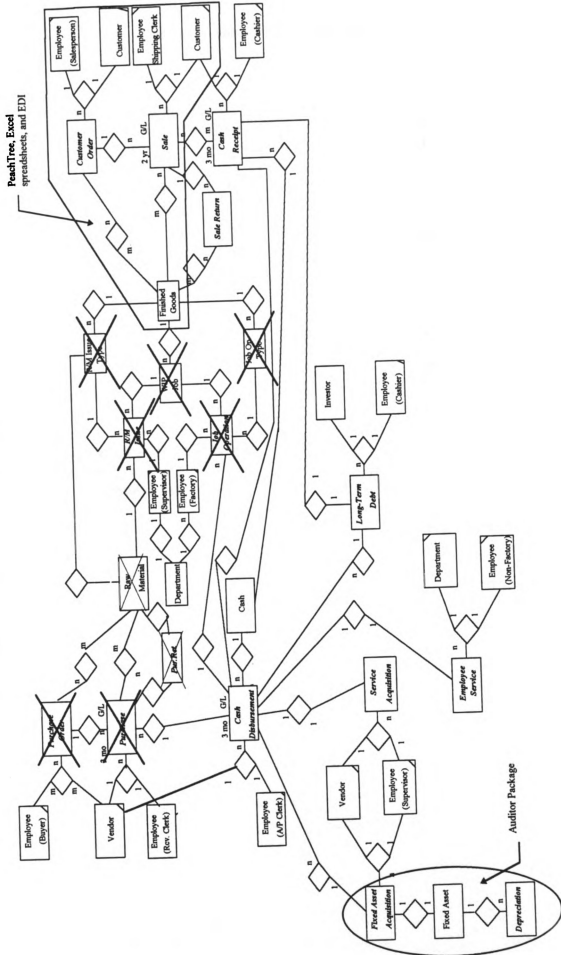
Implemented applications (Chart)	15
Other system characteristics (p.1)	0
System Total	15
Organization characteristics - Accounting	-41
Organization characteristics - MIS	32
Sales/Marketing Management (Div2)	25
Sales/Marketing Management (Div1)	5
Sales/Marketing Staff (Order Entry)	15
Production Manager	25
Production Supervisor (Div2)	-5
Production Supervisor (Div1)	15
Distribution Manager (Shipping and Receiving)	0
Accounts Payable	0
Invoicing	10
Div3 Management	25
Average department characteristics	11.5
Organization Total	81
Grand Total	96

Accounting Systems Characteristics Questionnaire: Madison



Summary Sheet - Madison

Implemented applications (Chart)	30
Other system characteristics (p.1)	-7
System Total	23
Organization characteristics - Accounting	-48
Organization characteristics - MIS	50
Purchasing	25
Purchasing Staff	5
Production	15
Production Staff	25
Sales	20
Sales Staff	5
Distribution	0
Distribution Staff	15
Organization Total	112
Grand Total	<u>135</u>



Summary Sheet: West Lafayette

Implemented applications (Chart)	5
Other system characteristics (p.1)	-21
System Total	-17
Organization characteristics - Accounting	-32
Organization characteristics - MIS	0
Purchasing Executive	-10
Production Manager	-15
Sales Executive	-15
Marketing Manager: Radio Marketing	-20
Marketing Executive	-5
Marketing	-20
Specialty Sales	-20
Order Processing	-20
Customer Service	-20
A/R and A/P	5
Design Department	0
Average department characteristics	-12.73
Organization Total	-127
Grand Total	-176

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