Factors That Drive Purchasing and Supply Management’s Use of Information Technology

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Abstract—Purchasing and supply leaders continually search for ways to improve the quality, delivery, and cost of production inputs. Their participation in these proactive supply chain activities can be a significant driver of purchasing and supply management’s use of information technology (IT). Using a transaction cost analysis perspective, we surveyed purchasing and supply professionals at the director level or above from the Institute for Supply Management database to determine whether five common purchasing activities increase the need for purchasing professionals to use IT. The purchasing activities studied are 1) supplier alliance; 2) market monitoring; and 3) cost management (including cost analysis, total cost of ownership, and target costing). Of these activities, supplier alliances and cost analysis were found to significantly influence purchasing and supply management use of IT. In addition, industry effects were also discovered, where purchasing professionals in organizations that focus on producing high technology products and services utilize IT to a greater extent than purchasing professionals in traditional manufacturing and service organizations. The findings suggest that while there is evidence of a relationship between purchasing and supply management’s participation in proactive activities and actual use of IT, more research is needed to understand how information and technology can better facilitate purchasing and supply management activities.

Index Terms—Empirical research, information technology (IT), purchasing, supply management, transaction cost analysis (TCA).

I. INTRODUCTION

Purchasing and supply management (PSM) activities can have a significant influence on overall corporate performance. Significant advances in IT have supported PSM in conducting both strategic and tactical supply chain activities. Information technology requires significant financial investment and extended effort to ensure confidentiality and compatibility of systems. This is compounded as we move from electronic data interchange (EDI) to the Internet and enterprise resource planning (ERP) applications [56]. Many PSM activities require frequent, real-time communication flows with suppliers to bridge organizational boundaries.

The purpose of this study is to determine which, if any, PSM activities significantly influence the extent of PSM’s actual use of information technology (IT). Using transaction cost theory, the research hypothesizes that the PSM activities of supplier alliances, market monitoring, and cost management are associated with greater usage of IT. The IT tools studied in this research are the following:

1) electronic data interchange (EDI);
2) enterprise resource planning (ERP) systems;
3) the use of the Internet for research;
4) online auctions and Internet purchases;
5) intranets;
6) extranets.

Empirical results based on survey data indicate that the activities of supplier alliances and cost analysis significantly influence the extent of PSM’s actual usage of IT.

The following section begins with the overall theoretical underpinnings of PSM’s usage of IT from a TCA perspective. The three purchasing activities hypothesized to influence PSM’s involvement in IT are then discussed. Next, the six information technologies studied in this research are presented. Implications for practice are discussed throughout the final sections of the manuscript.

II. LITERATURE REVIEW

Information technology has become crucial in facilitating PSM activities that promote overall corporate success. This exploratory research examines how the PSM activities of engaging in strategic alliances, monitoring the supply market, and managing cost influence IT usage from the theoretical framework of transaction cost analysis (TCA).

A. TCA

The theory of TCA describes the ideal type of organizational governance structure for a transaction based on the characteristics associated with the transaction. TCA theory focuses on the transaction or “business deal” as the basic unit of analysis in determining whether the preferred organizational governance structure is to use the market (buy) or the firm (make internally) to produce or purchase products and services [61]. TCA assumes that human agents are subject to bounded rationality and that some agents are prone to opportunism. The underlying goal of TCA is to recognize and reduce uncertainty and the potential for opportunism associated with business transactions, thus reducing the risk and cost of conducting business.

Critical characteristics for describing transactions in TCA are the uncertainty associated with the transaction, the frequency of transaction, and asset specificity [62]. Asset specificity has three aspects. Site specificity considers how a favorable location economizes on inventory and transportation expenses. Physical asset specificity includes special production equipment and
human asset specificity encompasses the specialized training, knowledge, and skills of employees. With higher levels of uncertainty and asset specificity, there is greater potential for opportunism. Transaction cost analysis views negotiating, monitoring, and enforcing contracts as transactions, all of which have associated costs [49]. By better understanding and managing the number of transactions, management can reduce the associated costs. An analysis of transaction costs influences the firm in its supply chain structure choices.

Early applications of TCA focused on the decision to outsource or to vertically integrate the production of goods or services [57]. Outsourcing is a general term for the hiring of value-added activities such as manufacturing and services from another firm [10]. In contrast, vertical integration attempts to manage and control channel efficiency through ownership [22]. Factors generally considered in the decision to vertically integrate or outsource production and services include: cost; quality; delivery; supply assurance; control; fit with corporate objectives; strategy; social, political, and environmental concerns; secrecy; market conditions; and excess capacity [16]. From a strategic perspective, the PSM function plays a critical role in the firm’s choice between vertical integration and outsourcing and also has an extensive role in implementing the final decision. If a firm opts to vertically integrate functions, purchasing will be responsible for obtaining the required goods or services to enable manufacturing or service performance. If a firm chooses to outsource, purchasing must play a role in the evaluation, selection, and relationship building with the outsourced provider.

More recent studies using TCA as a theoretical base have focused on relationships [20], [45], [54]. Lamming and Hampson [34] have postulated that when a collaborative approach is employed with suppliers, firms can develop a better understanding of the impact of the relationship on supply chain performance. Firms that form strong relationships with certain suppliers can better align their interests and goals with those of their suppliers. This research posits that PSM needs to take a leadership role in relationship building with suppliers since PSM serves that boundary-spanning role. If trust has been built between a purchasing firm and key suppliers, vertical integration may not be necessary as assets such as equipment and job skills become more specialized. The establishment of trust reduces the risk of opportunism for both the purchaser and the suppliers with whom close relationships have formed [11]. The collaboration formed between these organizations can facilitate a focus on improved performance in that supply chain link. Each firm can then focus on its core competencies.

B. PSM Activities and TCA

From a transaction cost perspective, strategic alliances are a hybrid governance structure that emerges to glean the benefits of vertical integration without risk and inflexibility of ownership. Strategic alliance activities require significantly greater exchanges of strategic as well as tactical information in order to achieve successful outcomes [31]. Information exchange may include proposals for product changes, volume requirements, and shipment notices and often have time urgency. Therefore, the increased implementation and use of IT applications such as ERPs, EDI, and Extranets, will result when the PSM function actively engages in alliance relationships with suppliers. PSM also engages in relationships with suppliers that are outside of alliance relationships. As discussed by Ellram [24], Kraljic [32], and Steele and Court [53], supplier alliances should be reserved for suppliers that provide critical items that pose significant risk to purchasing firms. Purchasing firms can be subject to supplier opportunism when procuring items that require high degrees of asset specificity without engaging in strategic alliance relationships with those suppliers. This may occur because the purchasing organization lacks knowledge of the supply source. In order to reduce supplier opportunism and information asymmetries [21], the PSM function can increase its awareness of the supply market. As discussed by Monzcka, Trent, and Handfield [42], sources of market information available to PSM professionals include current suppliers, sales representatives, information databases, experience, trade journals, trade directories, and industrial trade shows. With the advent of technologies such as the Internet and the ability of separate business units to communicate via Intranet platforms, purchasing professionals can become more astute in understanding supply market activities. Therefore, market-monitoring activities require the PSM function to become actively involved in actual use of various IT applications to better assess supply market trends and opportunities.

A third set of activities that PSM has and continues to be involved with is cost management. Three cost management approaches are included here: cost analysis, total cost of ownership (TCO), and target costing. Cost savings experienced in acquiring supply items and services has a direct benefit to overall corporate profitability [44]. In order to promote significant cost reductions, the PSM function often becomes extensively involved in implementing tools to understand and manage cost.

One of the most important activities that PSM engages in is cost analysis. Many cost management activities, such as examining supplier cost structures [24], encouraging suppliers to share cost data, and developing cost structure databases, require the extensive use of IT. Cost data can be shared with suppliers through ERP, EDI, and Extranet linkages, as well as internally between business units and divisions within the same corporation. In addition, much excellent supplier cost data is available on the Internet through public sources such as the Bureau of the Census, the Bureau of Labor Statistics, and private sources such as industry associations and fee-based subscriptions.

Another tool that purchasing firms are using to a greater extent to manage cost is implementing total cost of ownership (TCO) analysis. TCO analysis is a structured approach for determining the total costs associated with acquiring a good or service [1], [24]. Many of the costs analyzed and eventually reduced or eliminated by purchasing organizations using a TCO model can be classified as transaction costs. For example, nonvalue added activities, administrative costs, and maintenance costs often occur at the interface between a buying and supplying organization. In order for PSM to execute a thorough TCO model to investigate pretransaction, transaction, and post-transaction costs [26], information about cost structures...
and drivers needs to be attained and, therefore, may drive the PSM function to actively implement and use information technologies to gather and capture such data.

Many proactive PSM organizations also use target costing in their portfolio of cost management tools. Target costing involves analyzing an item’s estimated selling price, less profit, then determining the overall allowable cost for acquiring a good or service [15]. Detailed information exchange between buying and supplying organizations is critical for assessing cost reduction opportunities needed in order to meet customer price requirements. This includes transaction costs between the buying and supplying firm [15]. Thus, it stands to reason that the PSM organization will utilize IT significantly in order to successfully reduce costs in their target costing activities.

All three of the cost management approaches presented are designed to reduce organizational cost uncertainty around purchases and minimize the chance for opportunism, which is highest where assets are specific. Research information is also provided about the Internet as a tool to develop and capture such data to corroborate supplier cost structures and proposed price changes.

### C. TCA, IT, and PSM Activities

The implementation and use of information technologies that span the purchasing organization and connect it with suppliers often involves a significant financial investment, sometimes in specific assets. IT applications such as ERP, EDI, and Extranets can “lock in” the relationships between purchasing and supplying firms. These investments may be made with the goal of reducing the overall transaction costs between purchasing firms and their suppliers.

As mentioned previously, the ultimate goal of transaction cost theory is to recognize uncertainty and reduce the costs associated with business transactions, including opportunism costs. With greater information sharing between two distinct organizations, a close relationship between a buying and supplying firm can be formed. As suggested in previous research grounded in TCA, information exchange can allow purchasing organizations to enjoy some of the benefits of vertical integration such as uncertainty reduction and long-term transaction cost savings without acquiring the supplier organization or vertically integrating the manufacture of noncore competency items [22]. In order for organizations to truly capitalize on IT investments with supplier organizations, it becomes critical that PSM, as a boundary-spanning function, is involved in the implementation and use of these technologies. Information sharing facilitated by IT, coupled with strategic alliances and market monitoring, can reduce the uncertainty of supply and demand for buyers and sellers. Better information also reduces the threat of opportunism that is often associated with asset specificity.

### III. RESEARCH CONSTRUCTS

Based on the results of prior research, we have hypothesized that several proactive and increasingly common PSM activities can influence the degree of PSM’s use of IT. This section opens with a review of current IT applications, followed by an explanation of PSM activities that are hypothesized to influence PSM’s actual usage of IT.

#### A. Dependent Variable: PSM Use of IT Applications

The PSM function often utilizes IT applications as one tool to achieve strategic and tactical goals [39]. The IT applications in this study are EDI, ERP, using the Internet for research, online auctions, and intranet and extranet technologies. These particular technologies were chosen because they are the technologies that are most frequently cited as existing and emerging technologies in the purchasing trade press (i.e., *Electronic Buyer’s News, Purchasing, Purchasing Today*). Previous studies have focused on the use of EDI to support PSM activities [38], [58] primarily because the other technologies are too new to have much data [60]. Studies are emerging on the use of other Internet-based technologies [39], [46], [51], [63]. However, these studies tend to focus on the application of a single technological tool, such as the Internet. Since ITs are often complementary [36], [64], the researchers chose to focus on emerging and existing types of IT to support PSM activities. Each of the ITs included in this research is presented in general and in relation to PSM.

1) **EDI**: EDI has been defined as “the transmission of standard business documents in a standard format between industrial trading partners from computer application to computer application” [58, p. 31]. One of the key applications of EDI has been in communicating requirements to supplier organizations, as EDI has been found to reduce the cost of the paperwork in generating an order [38]. Additional PSM-related benefits attributed to EDI include reductions in delivery lead-time and inventory levels, lower error rates and less clerical effort required to complete purchase orders [58], all of which significantly reduce the transaction costs between buying and supplying firms.

Many companies have invested millions of dollars in EDI solutions and likely will not abandon EDI in the near future [6]. While the Internet and extranet have replaced some aspects of EDI for some organizations, EDI will continue to play an important role in interorganizational information exchange [43].

2) **ERP**: ERP applications are software packages that encompass everything from order capture to accounting and procurement to warehousing [36]. Leading providers of ERP software include SAP, Peoplesoft, Oracle, Baan, and JD Edwards. ERPs centralize control over information and processes [17]. The great appeal of ERPs is that employees enter information only once and that information is then available to all systems company-wide [36]. In theory, everyone in the company can make decisions based on accurate, real-time information. This has resulted in dramatic gains in productivity and speed. From a PSM standpoint, implementation of an ERP can improve communication with marketing (regarding firm and forecast sales), with logistics (regarding inbound materials), with operations (regarding materials requirements planning) as well as with other functions by providing a common database and communication tool throughout the organization. While ERP systems are generally internally focused, when a supplier has the same ERP software as its customer(s), external information exchange may also be seamless, with no data translation involved.
3) Internet for Research: Among the primary duties of proactive purchasers is to stay in touch with the external supply market in terms of supply availability, pricing, technology developments, and new entrants [9]. The Internet is one tool that can provide large amounts of information for purchasing on products or suppliers. More than 90% of purchasers responding to a recent survey indicated that they currently use or plan to use the Internet to research potential suppliers [41]. Carbone [7] has noted that the Internet is a useful tool for research, but many purchasers have found that Web sites can sometimes be difficult to navigate. With Internet technology and applications growing at such a rapid pace, the use of the Internet to facilitate market monitoring activities and communicating information with suppliers will become even more prevalent.

4) Online Auctions/Internet Purchases: Online auctions are one tool purchasing organizations may utilize for obtaining goods and services. As noted by Teich, Wallenius, and Wallenius [55], many different types of electronic auctions exist. E-auctions can include such features as reservation prices, automatic bidding, rules regarding auction closing, the item(s) and quantities offered (one or multiple), and whether there is a regular (forward) or reverse procurement auction. Reverse auctions are popular for electronic business-to-business transactions. From a TCA perspective, one advantage of reverse auctions is that they can inexpensively connect buyers and suppliers worldwide and can theoretically drive the price of a purchased good or service to its “true market price” [51]. However, electronic auctions and even the Internet, may be more appropriate for standardized maintenance, repair, and operating (MRO) items, rather than specialized materials or capital equipment [48].

In addition to auctions, the purchasing function can also obtain goods and services through Internet sites. It has been argued that the Internet can provide either a decrease in cost for a given level of performance/quality, or a higher level of performance at a given cost [12]. However, there are also potential drawbacks to Internet purchases. For example, complex products or designed-in materials may be difficult to obtain over the Internet [18]. In addition, poor supply chain execution can eliminate any price advantage by creating a need for buffer inventory, causing lost revenue through shortages, or increasing costs through expediting orders [18].

The use of the Internet for purchasing applications seems to be growing. In a recent study, more than half of buyers who have access to the Internet at work have purchased parts from suppliers over the Web, with 60% of those individuals being regular buyers [7]. However, volumes are currently small, where 72% of buyers purchase 5% or less of the total purchase volume over the Internet [7]. All indications are that the purchasing via the Internet, including online auctions, is on the rise.

5) Intranets: An intranet is a network for transporting information within and among corporations [5]. The focus of intranet systems is on the internal exchange of information within a company. Use of tools such as intranets are important in increasing internal communications among the PSM department regarding policies, contracts, and leverage agreements with suppliers. Intranets can help streamline processes, eliminate redundancy, and help focus buyers on more value-added activities. As was the case with the implementation of purchasing cards, intranet procurement systems have been implemented to control unauthorized purchases and enforce negotiated prices [50]. However, cost savings do not occur immediately. Some firms that adopt intranet applications discover that the software sometimes takes months to roll out and that end users need time to adjust to new browser-based systems [50].

6) Extranets: An extranet is a secure, password-protected area on a Web site that contains customized business information [7]. Supplier extranet applications often include inventory replenishment, collaborative research and development, and intercompany processing for nontransaction processes such as damaged-goods returns, insurance claims, and forecasting [3]. Organizations such as Ford, Chrysler, Intel, and Deere rely heavily on their extranets to communicate a range of tactical and strategic information to suppliers [43]. Extranets support more efficient procurement processes, resulting in cost savings. In addition, the extranet supplies a significant amount of data so that the purchasers can analyze trends and negotiate better deals.

Carbone [6] has noted that most Internet buying of components involves small volumes and accounts for less than 1% of the average organization’s sales. In contrast, extranets, such as Intel’s site, handle large volumes of parts. Extranets are becoming increasingly popular with suppliers who do not have EDI capability because they generally require only Internet access to be functional and can perform many of the same functions as EDI.

B. Independent Variables: Proactive Purchasing Activities

This section presents the independent variables that are proposed to influence PSM’s use of the previously presented information technologies based on TCA. The purchasing activities analyzed were supplier alliances, market monitoring, cost analysis, TCO, and target costing.

1) Supplier Alliances: Purchasing firms can engage in relationships with suppliers that range from arm’s length, to typical small account management, to national account management, to alliances, joint ventures, then to full vertical integration [14]. From a transaction cost perspective, alliances can be thought of as a hybrid governance structure, bringing together the advantages of vertical integration with the advantages of independent ownership [20], [22]. An alliance or partnership involves a business relationship between two separate organizations based on mutual trust, openness, shared risk, and shared rewards that yields a competitive advantage resulting in business performance superior to that of the firms individually [33].

Supplier alliances can provide a purchasing organization with many of the benefits that can be found in ownership, such as greater coordination, improved product designs [59], and faster response to market changes. Supplier alliances can facilitate sharing greater levels of information, pursuing mutual goals, and obtaining synergies from participant expertise. Sharing information with supplier partners requires greater use of IT applications [31]. Therefore:

Hypothesis 1: The degree to which PSM is involved in supplier alliances is positively related to the extent to which PSM utilizes IT.
2) Market Monitoring: Market monitoring occurs when the purchasing organization stays abreast of issues outside firm boundaries that can have an impact on its supply. Previous research has shown that when PSM places more emphasis on managing the supplier market, cooperation and communications will increase with suppliers that provide critical or volume materials and/or services to the buying firm [8]. Market monitoring is critical to PSM’s ability to play a proactive role in the organization [12].

Monitoring the market is akin to the firm “keeping its eyes open,” which can be used as a tool for reducing the effects of supplier opportunism, as espoused in transaction cost theory. The Internet is one means for quickly studying and obtaining information. Increases in PSM involvement in monitoring the supply market will require the need for the increased use of technology tools to enable these efforts. Hence:

Hypothesis 2: The degree to which PSM is involved in market monitoring is positively related to the extent to which PSM utilizes IT.

3) Cost Management: PSM also engages in activities to manage the costs associated with acquiring goods and service. Three tools that proactive PSM organizations implement to manage costs, to include costs associated with the transactions between the purchasing and supplying organizations, are cost analysis, TCO, and target costing. The hypothesis for cost management and a discussion of the subhypotheses follows.

Hypothesis 3: The degree to which PSM is involved in cost management activities is positively related to the extent to which PSM utilizes IT.

a) Cost analysis: PSM’s ability to understand supplier costs depends on its use of IT applications to facilitate close communications and cooperation between trading firms. Organizations need to work in the best interests of the alliance and eventually the entire supply chain. While the level and depth of cost analysis varies with the supplier relationship, some type of cost or price analysis is required for all purchases of any significance. Price data for many standard items are now more readily available on the Internet. Cost data are also available. By better understanding costs, steps can be taken toward reducing these costs, making both firms more competitive in the marketplace. The availability of external cost and price data also reduces the possibility of opportunism, which TCA identifies as a problem when organizations lack market knowledge. Specific activities to increase understanding of supplier costs can include performing breakdowns of supplier cost structures, encouraging suppliers to share cost data, and developing a database of estimated supplier cost structures [24]. These activities may generate the need for increased IT sophistication in order for PSM to obtain timely, accurate supplier cost data.

Hypothesis 3a: The degree to which PSM is involved in cost analysis activities is positively related to the extent to which PSM utilizes IT.

b) TCO: TCO is a purchasing tool and philosophy aimed at understanding the relevant cost of buying a particular good or service from a particular supplier [24]. TCO is an important tool to support strategic cost management. It is a complex approach that requires the buying firm to consider significant costs above price in the acquisition, possession, use, and subsequent disposition of a good or service [26].

TCO analysis is conducted at the interface of the buyer and supplier firms [23]. One effect of TCO analysis is to encourage both the purchasing function and supplier to share information that drives out cost. TCO identifies many of the “hidden” costs associated with transactions such as uncertainty and asset specificity costs as noted in TCA. The identification of costs allows firms to work on reducing them. The high degree of information sharing may warrant a greater use of IT applications between the two organizations.

Hypothesis 3b: The degree to which PSM is involved in TCO is positively related to the extent to which PSM utilizes IT.

c) Target costing: Target costing integrates cost decisions of the firm with the costs of other firms in the organization’s supply chain. Each organization influences the others’ profitability. The target cost for an item is its estimated selling price less the profit desired for that item [15]. Target costing is a technique whereby the organization determines the price the market will bear and backs out desired profit; the amount remaining is the cost for which the firm can afford to make or otherwise procure the item. The target cost becomes the overall allowable cost for the product or service.

Target costing may drive the need for PSM to become more involved in IT applications due to the need for increased information sharing with its suppliers throughout the product/service lifecycle. Target costing is an information intensive process that attempts to reduce uncertainty and opportunism in the price and availability of supply through improved information about customer needs and supplier costs and capabilities. Therefore:

Hypothesis 3c: The degree to which PSM is involved in target costing is positively related to the extent to which PSM utilizes IT.

IV. RESEARCH METHOD

The hypotheses were tested with empirical survey data gathered from 261 respondents using hierarchical regression, controlling for organizational size, and industry. This section begins with a discussion of the target sample for this study. A summary of the study’s validity and reliability follows.

A. Sample

Purchasing professionals associated with the Institute for Supply Management (ISM) were the target respondent for the research due to their knowledge of purchasing and supply management practices in their organizations. The authors were provided a database of 2300 purchasing professionals with positions at the director level or higher. The questionnaire was sent to a random sample of 1000 individuals from the database.

A modified version of Dillman’s Total Design Method [19] was executed for the survey protocol. The first mailing was sent to the sample of 1000 purchasing professionals. A reminder postcard followed ten days later. A second mailing was then sent to nonrespondents two weeks after the postcard. Followup phone calls were made to all survey nonrespondents, beginning several days after the first mailing. Of the 1000 surveys that were mailed, 76 surveys were returned as unusable. A total of 261...
usable surveys were returned, resulting in an effective response rate of 28%. A multivariate test for nonresponse bias compared the first and second waves of responses according to firm size. Early respondents did not display statistically significant differences from late respondents, providing evidence that nonresponse bias was not present [2].

B. Variables

A questionnaire was developed after an extensive review of the literature related to proactive purchasing and supply management practices and discussions with PSM academics and practitioners. Responses to questions were anchored using a five-point Likert scale (1 = never/no extent/no involvement, 3 = sometimes/to some extent/some involvement, 5 = always/high involvement).

There were six questions used to test the extent of PSM’s actual usage of IT. The concepts supporting these questions were presented in the discussion of the dependent variable. Means and standard deviations were calculated for these individual items, as found in Table I. In addition, there were numerous items included in the survey instrument to test the independent variables of supplier alliances, market monitoring, cost analysis, TCO, and target costing. The wording of these items can be found in Table II.

Content validity was addressed by use of prior scales, when possible and expert reviews of the survey instrument [28]. Previously employed scales were used or modified for the purchasing practices of supplier alliances [4], [13] and total cost of ownership [25], [26]. Practitioners and academics with general business, purchasing and research experience reviewed the initial survey instrument extensively for content and face validity. Before the questionnaire was finalized, it was modified and pretested by several purchasing professionals and academics. The pretest included completing the survey and discussing interpretation of the questions with the researchers, as well as providing suggestions to improve any areas that were unclear or incomplete.

Construct validity was established through exploratory factor analysis [28]. The first factor analysis was conducted to derive the independent variable constructs from the survey data. Factors were extracted using the maximum likelihood method, followed by a varimax (orthogonal) rotation. As suggested by Hair et al. [30], an item was considered to load on a given factor if the factor loading from the rotated factor pattern was 0.40 or greater for that factor and less than 0.40 for the other factors. The eigenvalue one tests and screen test suggested that there were five meaningful factors. The factors were labeled Supplier Alliances (nine items), Market Monitoring (three items), Cost Analysis (three items), Total Cost of Ownership (four items) and Target Costing (two items). The independent variable items and corresponding factor loadings are shown in Table II. A second factor analysis was conducted for the dependent variable IT. Since there was only one eigenvalue greater than 1, no rotation was possible. Factor loadings for IT can be found in Table III.

Predictive validity investigates the empirical relationship between the results on a test instrument and an objective outcome [28]. As described by Flynn et al. [28], the most commonly applied measure for testing predictive validity is to derive a coefficient of the correlation between predictor (test instrument) and criterion (objective outcome) scores. Due to the newness of several scales and technologies (i.e., ERP, electronic auctions), the researchers were unable to derive objective outcome scores. However, from a thorough review of the literature, the researchers were able to determine the items measuring the independent and dependent variables accurately reflected the PSM practices of supplier alliances, market monitoring, cost analysis, TCO, target costing, and their relationship to IT usage.

Reliability and unidimensionality were both examined to test for internal consistency of the research variables. Reliability tests using Cronbach’s alpha were performed for each construct, as found in Tables II and III. Reliability estimates for all constructs were greater than 0.70, providing evidence that internal consistency exists with the items [30]. Next, summated scales were created for each of the constructs from the individual items that loaded on their respective factors [30]. Descriptive statistics of mean responses, standard deviations, sample sizes, and correlations for the constructs are presented in Table IV.

Unidimensionality, which is the existence of a single trait or construct that underlies a set of items [29], was evident in the purified factors due to the strong factor loadings and absence of cross-loadings. In addition, establishing unidimensional factors is an important facet for demonstrating convergent and discriminant validity in the survey instrument. Factor loadings for the independent variables and for the items measuring IT, can be found in Tables II and III, respectively.

V. RESULTS

A. Overall Use of IT

The six questions that make up the dependent variable “PSM’s involvement in IT” are shown in Tables I and III. Respondents indicated moderate to high involvement levels in using intranet applications and in using the Internet for
research. However, few respondents indicated extensive use of online auctions and Internet purchasing. This finding is congruent with prior observations that indicate that online auctions and Internet purchasing are still in the infancy stages and that some of these technologies such as the Internet are more suited as information gathering tools [7]. Other IT applications, such
as intranets, EDI, and extranets can be used for more strategic activities such as locking in key partners [3].

B. Descriptive Statistics of Constructs

Table IV shows descriptive statistics for all five PSM activities and the dependent variable. This analysis shows a high degree of correlation among all variables. However, all model variables were well within the variance inflation factor limit of 10, indicating that their multicollinearity did not have an undue influence on the coefficient estimates [27]. Variance inflation factor scores can be found in Table V.

The strong correlation among the variables instead suggests that the organizations studied tend to utilize or not utilize the proactive PSM practices studied as a “set” of practices. The variability in means among constructs shown in Table IV indicates that not all of these PSM practices are heavily used, or used to the same degree. Thus, it is meaningful to look at how the individual constructs representing proactive PSM practices are related to the use of IT.

C. Hierarchical Linear Regression

A hierarchical multiple linear regression was used to analyze which PSM activities significantly influence PSM’s use of IT. The first step in the hierarchical regression included control variables for organization size and industry effects. The proxy used for organization size was the self-reported number of employees in the organization, which was standardized using z-scores. The second control factor in the first block accounted for industry effects. Due to the variety of industries examined in the study, industry was segregated into three areas—1) high technology, 2) manufacturing, and 3) service. Examples of high technology companies include aerospace, software development, and electronics firms. Manufacturing firms include automobile manufacturers and suppliers, textiles, and food producers. Service organization respondents were from companies such as banking, transportation and health care sectors.

The second stage of the hierarchical regression model added the independent variable of supplier alliances. As found in the change statistics in Table V, supplier alliances provided a significant degree of explanation into the model testing PSM’s degree of involvement in the use of IT.

The third variable added into the model was market monitoring. As also found in Table V, this variable contributed to an improved model, as demonstrated by the change statistic in Table V. However, market monitoring was not a significant predictor of PSM use of IT.

The fourth and final block of variables added into the model were cost management. Specifically, cost analysis activities, TCO, and target costing were included as a block into the hierarchical regression model. Of these three variables, only cost analysis was found as a significant predictor for the degree of PSM use of IT. However, as a set of constructs, cost management did significantly add information to the overall empirical model, as shown in the change statistics in Table V.

The final regression model was highly significant, as indicated with an F-test of $7.715^{(8,214)}$ with a $p < 0.001$ and $r^2 = 0.224$. A check of the residuals and variance inflation factors indicated that heteroscedasticity and multicollinearity were not threats to the model [30]. Regression coefficients and variance inflation factors can be found in Table VI. An explanation of the findings related to each hypothesis follows and is also summarized in Table VII.
D. Empirical Findings

The section below presents the empirical results associated with the data testing. The results related to the control variables and each hypothesis is discussed.

Industry effects were confirmed when examining the control variables. Specifically, organizations from high-technology firms reported a greater degree of actual use of IT versus their counterparts in general manufacturing and service organizations, as found in Table V.

Hypothesis 1: The extent to which purchasing and supply management utilizes IT is positively related to the degree of involvement in supplier alliances. This factor explained the greatest amount of variance in the model, as shown in the $t$-test and change statistic. It contained nine items related to the closeness of working relationships and communication between supplying and buying organizations.

Hypothesis 2: The degree to which purchasing and supply management utilizes IT is positively related to the degree of its involvement in market monitoring activities was rejected. Market monitoring includes scanning the environment for changes in price, availability, and technology/standards. This was surprising, given the general belief that IT and the Internet in particular, facilitates information gathering and scanning. Instead, there may be other tools and techniques that PSM professionals use to monitor the supply market, as explained in detail in the Discussion section.

Hypothesis 3: The extent to which purchasing and supply management utilizes IT is positively related to the degree of its involvement in cost management activities. There was mixed support for the third hypothesis, where cost analysis activities were found to significantly influence IT usage. No significant relationships were found between total cost of ownership, target costing, and IT involvement. However, the inclusion of cost analysis, TCO, and target costing, as a group of variables, provided additional explanation in the variability of IT usage.

Cost analysis activities are very data intensive, including activities such as development of supplier cost breakdowns, supplier cost structures, supplier cost tables/cost models, and efforts to reduce supplier’s costs (see Table II). It is consistent that IT would support such data intense activities. In contrast, TCO analysis tends to be project oriented, with each study performed as a unique analysis [23]. To date, much of the benefit of IT has focused on improving efficiency of repetitive tasks rather than adding value from unique relationships [7], [18]. In regard to target costing, this technique usually follows a common process, where each individual application of target costing is unique to the product or the situation. Very little of the data used to support target costing comes from standard accounting systems or databases [15]. Most data required for target costing must be developed on an ad hoc basis. Since IT has focused on “repetitive” tasks [7], [18], it is logical that involvement in target costing does not significantly influence PSM utilization of IT as identified in this study.

VI. Discussion

Two of the five purchasing activities tested were found to significantly influence PSM’s use of IT. The IT applications included in the dependent variable were the following:

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Independent Variable</th>
<th>Direction</th>
<th>Supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Supplier Alliances</td>
<td>+</td>
<td>Yes</td>
</tr>
<tr>
<td>H2</td>
<td>Market Monitoring</td>
<td>+</td>
<td>No</td>
</tr>
<tr>
<td>H3</td>
<td>Cost Management</td>
<td>+</td>
<td>Partially</td>
</tr>
</tbody>
</table>

There was mixed support for the third hypothesis, where cost analysis activities were found to significantly influence IT usage. No significant relationships were found between total cost of ownership, target costing, and IT involvement. However, the inclusion of cost analysis, TCO, and target costing, as a group of variables, provided additional explanation in the variability of IT usage.
1) EDI;
2) ERP;
3) use of the Internet for research;
4) online auctions and Internet purchases;
5) intranets;
6) extranets.

The themes that emerge from this research are the impact of the nature of supplier relationships on PSM’s usage of IT and the need for IT to support ongoing data intensive PSM activities.

A. Impact of the Nature of Supplier Relationships

The results show strong support for Hypothesis 1, that PSM’s use of IT is highly related to its use of supplier alliances. As indicated in the literature [31], one of the keys to successful supplier alliances is increased communication and information sharing. For example, both electronic data interchange and extranets explicitly focus on improving information exchange among buyers and sellers [6]. Ford Motor Company uses extranets to provide key suppliers with metrics on supplier performance and improvements such as information on product development, including process engineering issues, CAD-CAM drawings and information related to new vehicle launches [40]. Thus, Ford uses its extranet to facilitate information exchange with its supplier alliances.

As working relationships between buyers and suppliers become closer, it is more likely that PSM will use various types of IT. Organizations such as Deere & Company and Intel specifically use their secure extranet sites to communicate important information such as forecasts and planning data to their key suppliers. Due to the cost of setup involved in many technologies, such as secure extranets and EDI, it does not make sense for organizations to establish such IT linkages unless they have a stable supply base characterized by close working relationships. Thus, the presence of ongoing relationships with suppliers through supplier alliances is strongly associated with PSM’s use of IT. This is supported by TCA, which indicates that asset specificity, while creating economies, may also lead to opportunism unless there is a credible commitment, such as an alliance relationship, among firms [22].

B. Support Data Intensive PSM Activities

Hypothesis 3—the extent to which PSM utilizes IT is positively related to the degree of its involvement in cost management—was partially supported in this study. Cost management activities require a large amount of internal and external data in order to be effective. The items included in the construct “cost analysis” consist of developing breakdowns of supplier’s costs, working with suppliers to disclose costs and cost structures, and developing a database of estimated supplier cost structures. These efforts can be facilitated by maintaining and accessing historical records, such as in an ERP or intranet system, as well as external data mining via the Internet and sharing that data with suppliers through the extranet. Cost analysis requires both external and internal information, as well as historical data on actual past performance. It is an ongoing process that requires similar types of data from similar sources over time. Thus, cost analysis may involve human asset specificity in terms of skills and knowledge related to the supplier and its cost structure. As indicated by TCA, such knowledge by the buyer may prevent supplier opportunism. Retaining this knowledge via intranets, Internet data, ERP systems and other IT tools institutionalizes the knowledge, rather than making it employee specific.

The other two factors associated with cost management, TCO, and target costing, were not found to individually influence PSM’s involvement with IT. While TCO and target costing are also very data intensive activities, they tend to be project-oriented rather than ongoing. Most of the data required for TCO and target costing analyses are estimated rather than actual, based on projections and approximations. In addition, Chopra and Van Mieghem [12] have noted that the purchase of products using auctions may lower the purchase price, but often increases the total cost of purchase for a company. Thus, some IT applications may actually be counterproductive to the goals of TCO and target costing. Based on the findings, utilization of IT as defined here is not as important to PSM’s deployment of TCO and target costing. However, as we move to more collaborative information system software and structures in the future, it is likely that this will change as buyer and suppliers work with flexible IT systems to develop, understand and manage cost.

Hypothesis 2—linking PSM’s IT utilization to PSM’s degree of market monitoring—was not supported by the data analysis. This is perhaps the most surprising finding to the researchers. One explanation for this finding can be found in the correlation matrix in Table IV. Although there was no evidence of multicollinearity in the research model, there are correlations between market monitoring and the other research constructs. Market monitoring had strong coefficient of 0.099, but the marginal effect was not significant due to the other variables in the model. However, including market monitoring in the hierarchical regression provides additional explanation in the research model as demonstrated by the significant $r^2$ change. In addition, the overall model F-statistic $F = 7.715 (p<0.04)$ shows that as a group of variables, supplier alliances, market monitoring, and cost management provides evidence that these PSM activities do influence IT usage.

New IT, such as the Internet, provides access to a wealth of data related to market pricing, availability, and trends in the technology/lifecycle progression of purchased items. Each of these items had a high loading on the construct market monitoring. Everything from government web sites on commodity and labor price trends, to the National Association of Purchasing Management’s Report on Business, to industry association websites and hubs like the well-established chemical industry website provide buyers with almost instant access to market trends and information [38]. In addition, some organizations are putting supplier catalogues on their intranets, giving internal users instant access to market information in terms of competitive pricing and availability from competing suppliers. Suppliers are also creating secure extranets that buyers can access to obtain the latest price and availability information, allowing buyers to shop around and/or plan their requirements accordingly. Today’s IT has really created a revolution in terms of access to many types of market data.
VII. Conclusion

This section begins with a summary discussion of the research findings. Research limitations are then presented, followed by suggestions for future research.

A. Summary of Findings

With the rapid evolution and adoption of IT, there has been limited empirical research exploring how other activities that an organization engages in influence its use of IT. This study suggests that, from a TCA perspective, a relationship exists between certain types of PSM activity and the actual use of IT. The nature of buyer–supplier relationships, such as using supplier alliances, has a strong positive influence on PSM’s use of IT. In addition, IT is used for data gathering in terms of monitoring and sharing supplier cost data on an ongoing basis. This is very much in line with TCA, which indicates that supplier opportunism is likely in dependent relationships unless the other party, in this case, the buyer, retains market knowledge. Cost analysis using IT tools provides this balance to buying firms.

Surprisingly, no significant relationship was found between PSM’s involvement in the use of IT and market monitoring. Market monitoring has long been a mainstay of PSM and many printed newsletters and subscriptions exist to support general market monitoring activities. In the future, the authors anticipate that many of these will migrate to online only applications on secure websites, akin to the data sources for cost management.

The use of very specific, project-oriented cost management approaches such as TCO and target costing do not account for significant variability in the use of IT among the firms studied. These two cost management approaches require very specific internal and supplier information which often has to be developed on a case-by-case basis, rather than easily specified within existing information systems.

These findings have several managerial implications. First, the nature of buyer–seller relationships strongly influences the use of IT by PSM. To the extent that timely two-way information exchange is needed to support effective buyer–supplier relationships, PSM will use IT.

In addition, PSM should not underestimate the potential value of IT in cost management. This includes everything from using the Internet for research to accessing the supplier’s extranet to understand its costs, pressures, and future direction. Information technology can be vital in these arenas to reduce the overall transaction costs and risk of opportunism associated with obtaining goods and services from suppliers.

On the other hand, when engaging in very complex, specific analysis, such as using target costing to support new product development, IT as it is used today and defined in this study has less value. Each target costing process and most TCO analyses are unique. These approaches require one-on-one exchanges of information and projection of future trends rather than a generic approach such as that specified by ERP systems and EDI. While it appears that future systems are being designed to address such distinctive issues, most IT today is focused on widespread, generic applications in order to gain economies of scale and scope.

The lack of relationship among those IT applications that are in common use today with market monitoring, target costing and total cost of ownership also represents an opportunity for managers and consultants. Astute PSM professionals may still monitor supplier markets by using trade publications. However, with more information being made available in electronic formats, “real-time” information tools such as the Internet may slowly replace these trade publications.

Target costing and TCO analyses are often used for more critical, strategic purchases and viewed as strategic processes [24]. Finding ways to utilize IT applications to make these approaches more efficient and less time-consuming could help PSM gain a great deal of recognition and attention. More strategic IT utilization could also represent a major business opportunity for consultants or the development of an independent business.

B. Limitations

The development of various types of IT is changing rapidly, as is its actual usage. This research captured the state of practices at a fixed point in time. Also, because those studied in the research are active in the purchasing profession through their affiliation with the Institute for Supply Chain Management, it is likely that their behavior represents “leading edge” trends of U.S.-based firms, rather than that of the average company anywhere in the world. As such, this study may make a contribution in terms of predicting PSM use of IT in nonleading edge organizations, provided that IT does not develop in a discontinuous manner.

A second limitation of the research was that a survey instrument was used to gather the data. This limits the depth of information gathered in favor of reaching a breadth of organizations. A survey offers limited ability to ask and receive meaningful responses to open-ended questions. Research methods such as case studies and focus groups may provide greater insights into how PSM activities drive the use of these IT applications.

C. Future Research Directions

With the rapid evolution of IT and its applications, unlimited research opportunities exist for studying the impact of the actual use of IT on PSM and for studying the impact of PSM activities on technology use. Longitudinal case studies would be beneficial to explore the sequence of implementation of various information technologies. Longitudinal case studies may also be helpful in understanding the benefits of information technologies over time. Do newer technologies supersede older in rapid succession and is there valuable learning that occurs in each generation of IT adoption?

Moreover, exploring the specific role that PSM plays in selecting and implementing information technologies would also provide insight to practicing PSM managers. How can and how does PSM contribute to the firm’s IT strategy? On the other hand, does a comprehensive IT strategy even exist for PSM, or is the selection and implementation of information technologies piecemeal and ad hoc? As information technologies continue to
evolve at a rapid pace, so will the nature of the research and the research questions of interest.

REFERENCES


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