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# Examining collaborative supply chain service technologies: a study of intensity, relationships, and resources

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**Abstract** Technology has the ability to heavily influence marketing and supply chain theory and practice. This research incorporates a two-study approach to examine the impact of collaborative supply chain technologies on retailer logistics service and financial performance, and ultimately on the overall performance of the partnership. In this study we discover dynamic interactions between collaborative technology categories, relationship quality, resource complementarity, and performance. The results support the importance of collaborative technologies, the role of different degrees of partnering, and the need for a better understanding of firm and partner performance. Ultimately, this study creates a foundation for future research across the domains of marketing and supply chain management incorporating the resource based view of technology and service-dominant logic.

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## Introduction

Research on interorganizational relationships is increasingly turning to the study of technology and its impact on performance (Song et al. 2007; Sundaram et al. 2007). Researchers have openly suggested that "(t)he future research in business seems to be tied to technological change" (Rust and Espinoza 2006; p. 1078). In practice, it is no surprise that many of the most important technological innovations today are directly linked to logistical operations and partner firm relationship management (Bowersox 1989; Mentzer et al. 1989). These technologies include the implementation of old standbys; including, EDI and point-of-sale systems and also new sophisticated innovations; such as enterprise resource planning and automated material handling equipment. These technological tools are being invested in with the ultimate hopes of streamlining processes, facilitating channel flows, and improving relationship efficiency and effectiveness influencing overall performance (Rogers et al. 1993). However, little guidance is available regarding differences among the variety of available technologies and their effective utilization to create opportunities for co-creation of value among supply chain partners.

Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party providers, and ultimately consumers. Since supply chain management integrates supply and demand management within and across companies, the discipline creates a natural link between operations and marketing as well as the study of marketing tactics and marketing strategy (Rinehart et al. 1989).[1] The Resource Based View of the firm (RBV) makes this interconnection even more evident since it concludes that supply chain performance is an end-to-end process (i.e. across the supply chain) driven by effective partner deployment of resources (Olavarrieta and Ellinger 1997) encouraging a service outcomes approach to management (Flint and Mentzer 2006).

Still, when it comes to the role supply chain technology plays in influencing the effectiveness of marketing efforts for firms, very little has been uncovered. In practice, most technological initiatives are contingent upon a satisfactory ROI. It is unfortunately common that many of these expenditures lead to negative returns for firms in the short term and undue skepticism about the utility of partnership technologies. Nevertheless, firms cannot afford to lag behind in quick and effective implementation of appropriate technologies. Mistakes in collaborative technology initiatives have performance implications for the focal firm and for its supply chain as an extended business unit. Studies addressing these issues typically focus on just one category (ex. Communication) or a specific type of technology (ex. EDI), hence offering limited guidance. Recognizing this gap, we present two interdisciplinary field studies examining the important association between performance and the use of 18 different technologies employed in firm partnerships.

## Conceptual development

Because technology plays a key role in supply chain partnerships and also helps enhance service levels across supply chains, we ground this study in the Resource Based View (RBV) of the firm (Barney 1986) and the Service Dominant Logic (S-D Logic) (Vargo and Lusch 2004).

### The resource based view of the firm and technology

Technology is often defined as a valuable firm resource particularly relative to marketing and supply chain management functions (Christensen et al. 2002). When resources are matched to strategy, they may become firm specific, and thus central to firm performance. Because technology plays a key role in supply chain partnerships, we ground this study in RBV (Barney 1986). Current conceptualizations of the RBV assume: asset/resource heterogeneity (firms must have resources that differ from other firms), imperfect mobility of assets (firm assets must not be able to move easily between firms), and *ex post* and *ex ante* limits on competition (environmental temporal limitations exist on competitive resource position and valuation) (Peteraf 1993). These assumptions allow for the comparison of resource bundles valued based on convertibility, rarity, imitability, and substitutability (Srivastava et al. 1998). Effective (marketing) technology and firm(s') abilities to utilize such technologies through well established interfirm relationships across the supply chain are argued to be valuable, rare, inimitable, and organizationally specific when managed correctly. This is similar to the resource-based prescriptions drawn by marketing researchers examining technology (Kim et al. 2006).

The focal outcome of RBV (Barney 1991) is the creation of extra-ordinary rents for the firm (Peteraf 1993). In a business-to-business context, service-related value is formed as the offering moves down the supply chain (Morash and Lynch 2002). Thus, under conditions of effective deployment (e.g., collaboratively used technology across a supply chain) the firms that make up the supply chain may generate superior value (Priem and Butler 2001). Specifically, assets become capabilities in combination with matched organizational processes (c.f. Day 1994). These marketing utility "bundles" include skills and knowledge that create *firm (and/or relationship) specific asset resource combinations* (Amit and Shoemaker 1993; Coff 2002).

The RBV managerial goal is the development of core competencies through leveraging a firm's strategic weapons. As such, a discrete information technology is not a core competency. Rather, a core competency is driven by a set of implemented technologies that influence a set of capabilities creating a core competency for firms. Core competencies are defined as "the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies" (Prahalad and Hamel 1990; p. 79). This indicates that for a firm to develop a technology based core competency the current collaborative value creation strategy would be dependent upon firm relationships (Day 1994). As firms across the supply chain focus on their core competencies, they are often forced to become more dependent on their business partners. Hence, several studies stress the importance of improvement of relationship quality across supply chain partners and its impact on service based performance and overall performance (Kim et al. 2006).

### Resource based service dominant logic

Recent research in marketing espouses a focus on service and services as key drivers of competitive advantage. This

[1] Council of Supply Chain Management Professionals—http://cscmp.org/

theoretical shift towards service based relationship marketing and long-term focused customer retention is highly apparent in S-D Logic (Vargo and Lusch 2004). According to S-D Logic, a firm's competence in developing collaborative service based relationships is a key resource in attaining a sustainable competitive advantage (Lusch et al. 2007; Powell and Dent-Micallef 1997). This is largely due to the growth in importance of "service marketing, customization, and relationship marketing" (Rust and Espinoza 2006; p. 1072) since the ability to build relationships leads to synergistic capabilities enhanced by firm core competency specialization (Hunt and Morgan 1995). Hunt and Morgan (2005) draw direct parallels between this S-D Logic and the RBV. They suggest that resource based perspectives are the guiding frameworks that support service driven competitive advantage. Furthermore, supply chain technology is gaining support as a serious source of "process" based capabilities driving competitive advantage (Richey et al. 2007).

While technological adoption research often focuses on static costs and cross-sectional outcomes, marketing theorists are turning to S-D Logic as a guide to a new understanding of technological relationships. Day (2006) suggests that static resources only become technological advantages when examined through the service delivery process. He suggests (supply chain) partnerships will only reap resource based competitive rewards when: 1) the weighted average of valuable resources is leveraged; 2) capabilities are integrated across firms, and 3) strategic clarity and focus exists. As supported in our research, Day (2006) stresses that combined service and resource based implementation drives competitive superiority and optimal outcomes.

Despite there being limited examination of S-D Logic in supply chain management research, there is a direct resource based connection that scholars recognize as important for future theoretical integration. Flint and Mentzer (2006) support this need and recognize that supply chain management is heavily service based. They emphasize that it is supply chain service consistency that ultimately influences competitive advantage. Moreover, in the supply chain co-production of value for customers, it is relationship-based resources (i.e. knowledge, technology) that can create a service advantage.

In sum, the examination of collaborative supply chain technologies and their interplay with interfirm relationships as well as their ultimate influence on logistical service quality and financial growth fall under the S-D Logic umbrella of views in three distinct ways:

1. S-D Logic views knowledge as an operant resource (Lusch and Vargo 2006)—a type of dynamic resource that can be utilized to create value for customers. Given that technological collaborations are in place to create knowledge out of data through analyses as well as storing and communicating the knowledge across supply chain partners (Rust and Espinoza 2006), there is a well established connection between this study and the S-D Logic view of co-creation of value using operant resources.
2. S-D Logic also suggests that network partners are primarily operant resources that should be utilized in co-production of services and in co-creation of value (Lusch and Vargo 2006). Since our study examines technologies that are utilized in conjunction with supply chain network partners as well the quality of relationships between such partners, the co-production and co-creation aspects of S-D Logic are suitably considered.
3. Finally, S-D Logic claims that economic growth and wealth are obtained through utilization of operant resources (Lusch and Vargo 2006). Once again, our examination of such operant resources as technology collaborations that creates, stores, and communicates knowledge and the quality of relationships with network partners as well as the influence of these operant resources on financial and service performance related outcomes connects this study to S-D Logic.

## Supply chain service and technological resources

Technology performs a critical function in understanding how supply chain partners uniquely co-create value offerings. For instance, research in S-D Logic suggests firms can develop superior market offerings if they adopt collaborative methods that minimize risk for the buyer and allow the firm to share gains within the channel and/or to the end channel buyer (Lusch et al. 2007). Technology opens the window on the operational interconnections (the knowledge) that improve the consistency of the value offering getting it 1) to the right place, 2) at the right time, and 3) in the right condition (Mentzer et al. 1989). Given the importance of technology to the management of these three fundamentals of supply chain management, one can understand the importance of developing a service-competency focused technology-enriched strategy.

In a recent presentation by Roland Rust at the 2005 Society of Marketing Advances Conference and in Rust and Espinoza (2006), a distinction was made across three overarching categories of service technology applications: 1) communication technology, 2) customization technology, and 3) data storage technology. Communication technology is technology that allows firms to interactively transfer knowledge and information across business partners, customers, and to the end user (Rust 1997; Rust 2001). Supply chain technologies that fit into this category can include electronic data interchange, e-commerce, enterprise resource planning, internet/extranet, physical distribution management systems, and point-of-sale technologies. Customization technology is developed for firms to personalize the product and service specifically to a customer or specific group of customers or retailers (Chiou et al. 2002; Gilmore and Pine 1997; Rust 2001). Some supply chain technologies that fit into this category include automatic replenishment systems, customer relationship management systems, and order management systems. Data storage technology is developed for firms to store information about the customer (Ballou and Masters 1999). Supply chain technologies that fit into this category include geographic information systems, customer relationship management systems, and intelligent agents.

It should also be noted that often a given technology can be put into multiple categories depending on the primary and secondary uses it serves towards achieving firm objectives. In practice, firms develop technology that can perform multiple roles like storage, analysis, and communication to create value additions for their business customers. So, while the distinct benefits of each application (like data analysis and customization, storage, and communication) are mutually exclusive, the applications themselves may include multiple benefits to create value for their customers. Viewing resources as bundles of multiple benefits is in line with Day's (2006) belief in the weighted average of resources—where a suggestion is made that the resources should not be ranked on any single benefit but an overall weighted average of all benefits provided by a resource should be considered.

Embracing these technological categories and grounding our perspective in RBV and the S-D Logic, our initial study examined how collaborative technology categories impacted two critical performance outcomes: firm logistics service performance and firm financial performance. Moreover, since collaborative supply chain technology relies on an interaction between at least two parties, we examine the impact of relationship quality in moderating the impact of technology on firm performance.

## Study I: collaborative technology categories and firm performance

As discussed above, at least three specific types of collaborative technologies exist—communication, customization, and data storage. Each category is specific and can be expected to impact the firms' bottom line. This belief is a point of consternation in industry for marketing and supply chain managers. Supply chain managers must examine the cost-service tradeoff of employing a certain technology to create value for the customer, the business partner, and their own firm. The hope is that the technological improvement will allow the firm to create, store and communicate knowledge that can be utilized to outperform the competition (Closs and Savitskie 2003).

### Supply chain communications technology and firm performance

One of the strengths of supply chain oriented collaborative technology is that it is said to foster information and knowledge based capabilities (Rust and Espinoza 2006). Kim et al. (2006) make a solid case for the use of communications technology in improving firm performance. Their study supports the belief that communications technology has the ability to positively impact information exchange and firm responsiveness. As communication technology becomes more advanced the related reduction of information overload should help improve marketing related performance (Ansari and Mela, 2003).

As managers, the ability to interactively communicate with customers and business partners has been heavily supported by the growth of electronic networks (Rust and Kannan 2002), search engines, and the internet (Rust 2001). It has also positively impacted supply chain management and logistics in a major way. Importantly, supply chain technology has been linked to service outcomes such as customer retention (Grazin and Kahn 1989), market share growth, and general sales growth (Kim et al. 2006). Additionally, cost focused improvements are sometimes possible thanks to communications technology positively influencing profit (Gilmore and Pine 1997) and investment impact (DiMaggio and Powell 1983). Since good communication helps firms respond to requests (Rogers et al. 1993), we suggest:

> H1: Firms that collaborate heavily in using supply chain communications technology experience superior: a) logistics service performance; b) financial performance.

### Supply chain customization technology and firm performance

The growth of access to customer information has assisted heavily in customization (Bucklin and Gupta 1999) and this in turn has fueled the growth of service customization technology across the supply chain. In fact, it has been suggested that "(t)he more technology is used, the more technology is needed to attend to ... smaller segments" (Rust and Espinoza 2006; p. 1074). Ultimately, customization is driven by supply chain technology and relationships (Waller et al. 2000). Across more flexible systems, the product must be moved quickly from development or out of postponement through to the end user (Gilmore and Pine 1997). This requires technology that can maximize logistics service (Bowersox and Daugherty 1995) through assessment of customer need (Stank et al. 1999). For instance, Just-in-Time agreements require highly customized delivery times and structures which require customization technologies like automated order management systems. It is therefore likely that a collaborative customization technology can play a significant role in driving customer experience.

Customization technologies work by allowing businesses to modify their offerings to local needs while at the same time benefiting from large-scale production. Today, a wide variety of firms use customization technologies in deterring new entrants by choosing its customization scope strategically (Dewan et al. 2003). Besides, these technologies might enhance customizing behavior of employees by providing them the necessary customer knowledge and motivation to adapt (Gwinner et al. 2005). In customization research, customers have been shown to develop tight and binding relationships with a firm if they are consistently satisfied (Kahn 1998). The ability to generate these relationships is facilitated by a technology's expanded ability to track customer preferences (Hernandez-Espallardo and Arcas-Lario 2003). This relationship can create a base of retained customers that can help support growth and market share. Also, understanding what customers want explicitly can reduce operating costs and improve financial performance (DiMaggio and Powell 1983). Given this discussion, we suggest:

H2 Firms that collaborate heavily in using supply chain customization technology experience superior: a) logistics service performance; b) financial performance.

## Supply chain data storage technology and firm performance

The ability to collect psychographic and demographic data (Wind 1978) as well as capture operating data (Bowesox and Daugherty 1995) has been a key to the growth and effectiveness of data storage technology. The extent of use of necessary technology for data storage is a good indication of a firm's enhanced ability to access quality data when needed, and also of the ultimate managerial intent of putting available data to effective use through data mining and subsequent marketing/sales execution routines. Having the data to support specific decisions has the potential to make supply chain strategy and tactics more effective and efficient (Hogan et al. 2002) largely thanks to the improvement of data collection and integrated databases (Bucklin and Gupta 1999).

From a more specific end user position, data storage technology allows a better understanding of customer needs and wants improving retention through the adjustment of future offerings (Parasuraman and Grewal 2000). Thus, the result should be improved performance. Additionally, data storage technology should allow firms to identify and avoid the servicing of more costly customers, enhancing financial performance (Bolton et al. 2003). Given the logic supporting a relationship between data storage technology and performance, we suggest:

H3: Firms that collaborate heavily in using supply chain data storage technology experience superior: a) logistics service performance; b) financial performance.

## Relationship quality, technology category, and firm performance

Relationship quality has been shown to be involved in the effective management of technology and improved performance outcomes (Gronroos 1995; Varki and Rust 1998). Better relationship quality possibly leads to more data sharing and greater adaptability and flexibility whenever the partners' technological resources face incompatibility caused by diversity of technology platforms and legacy systems. In extant research on the relationship between technology and firm performance, direct effects are sometimes found and sometimes are not. This may be due to a growing belief that an interaction exists between relationship quality and technology (Sundaram et al. 2007) and relationship quality and performance (Cunningham and Joshi 2002). Considering the fact that technology is a resource rather than a capability, we suggest that a moderating effect may exist given a high quality relationship between firms. This can be explained by both RBV and S-D Logic. RBV's assertion is that an organization has a higher likelihood of attaining sustainable competitive advantage when it bundles its valuable resources to create a less imitable or substitutable competence. A high quality relationship might be a pre-requisite for more effective and efficient utilization of supply chain technologies yielding superior outcomes. Moreover, S-D Logic states that network partners are operant resources for firms to utilize to co-create value. Therefore, firms need high quality relationships with their network partners to work in a collaborative manner to co-create superior value by utilizing the shared technologies. Hence, we suggest:

H4: Relationship quality positively moderates the relationship between logistics service performance and the firm's level of collaboration in using: a) communication technologies; b) customization technologies; c) data storage technologies

H5: Relationship quality positively moderates the relationship between financial performance and the firm's level of collaboration in using: a) communication technologies; b) customization technologies; c) data storage technologies

## Methodology

An electronic survey was employed to collect data for Study I. The sample for the study was drawn from the retail membership of a Council of Supply Chain Management Professionals (CSCMP) database. CSCMP has a highly diversified membership of firms across industries and environments, a fact that enhanced the generalizability of the study (Schwab 1999). Additionally, retailers from over 25 different industries were included in the study. The retail members of CSCMP focus intensively on supply chain and marketing related technology in partnering relationships and this matched the objectives of our study. The sample frame focused specifically on senior marketing managers or supply chain managers involved in the implementation and management of supply chain technologies. To refine the study, exploratory interviews were conducted. Experts from the fields of retailing, manufacturing, wholesaling, and education (academics) were contacted to examine the relevance of the research questions This exploratory analysis involved intensive interviews by a three-member team. A survey was developed following these interviews and an extensive review of the literature.

The survey was conducted in four waves of emails. The first included an introduction message, a link to a survey tailored to the retail context, and a lottery incentive of $500. The following week a second wave of survey emails was sent as a reminder to the respondents. Four weeks following the first survey emails, a third wave was sent to all non-respondents as a reminder. Finally, a fourth wave was sent to non-respondents. Also, follow up phone-calls were made after each emailing. In total a member sample of 400 retailers was randomly selected from the database provided by CSCMP. When the surveys were completely administered to the executives responsible for technological implementation and supplier relationships the testable sample size included 170 firms (19 returned invalid: response rate of 38%). Responding retailers ranged in size from those that employed less than ten employees to those that employed over two hundred thousand employees (Median=500). In order to avoid non-response bias, all respondents were subject to a wave analysis using MANOVA. Indications of non-response bias were not found based on the wave analysis (Armstrong and Overton 1977). Industry bias was also tested at this point with no significance. Finally, as the performance outcomes were perceptual, reliability tests were run against annually reported financial outcomes. Using a standardization procedure creating linearly equidistant z-scores for the available reported financials from annual statements, we examined an ANOVA and discovered no significant differences across the dataset for perceptual versus reported financial results. Thus, the perceptual data were considered robust.

### Categorizing technology applications

To segment existing supply chain technologies into the categories identified by Rust and Espinoza (2006), we first collected information on firms' usage of eighteen different technologies most commonly implemented in supply chains today as identified by a panel of ten experts on supply chain technology. The exact wording in the questionnaire was: "Which of the following technologies do you use in conjunction with your primary supplier? (By primary we mean the supplier that you buy the most from in terms of dollar volume)." These technologies included automated materials handling systems, automatic replenishment systems, capacity resource planning systems, customer relationship management (CRM) systems, distribution resource planning systems, electronic data interchange (EDI), enterprise resource planning systems, e-commerce, geographic information systems, intelligent agent purchasing systems, internet/extranet, manufacturing resource planning systems, network management systems, order management systems, physical distribution management systems, point of sale, bar-codes/UPC Scanners, and warehouse management systems. The experts also noted the future importance of radio frequency identification (RFID), but were concerned that too few firms were applying RFID technology to supply chain processes for relevant inclusion in our study. As mentioned earlier, the selected technologies were next systematically categorized into communication, customization, and storage technologies. Using academic as well as practitioner oriented literature we collected the exact definitions (where possible), primary use, and also any secondary use for each technology. Online resources of several leading practitioner and consulting organizations were also referred to for identifying each technology. Subsequently, three academic expert judges put each technology into one of the three categories depending on its commonly accepted definition, primary benefits, and secondary benefits as reported in the literature. Any differences of opinion were resolved through discussion sessions among the judges, and the categorization was arrived at unanimously. A summary of the eighteen technologies is included in Appendix A.

### Measures and psychometric analysis

We operationalized the firm collaborative technology applications categories by giving scores towards a firm's shared utilization in each of the eighteen technologies. Here we recognized the integrative nature of supply chain technologies, i.e. that supply chain partners use various technologies as a system, serving several purposes simultaneously, with the goal of co-creation of value. In other words, no technology works in isolation and serves only a single purpose. Thus, primary as well as secondary benefits of each of the technologies were identified by the three expert judges. For example, if a firm mentioned that it used CRM system technologies, we gave a score of 2 towards that firm's collaboration in using customization technologies, because the primary benefit of CRM technologies was identified by expert judges as "enhancing the customization capabilities of a firm." Additionally, because the secondary benefit of CRM technologies was identified by judges as "facilitating storage of customer information," we also gave a score of 1 towards that firm's collaboration in using storage technologies. The same procedure was followed for each of the eighteen technologies and finally these assigned scores were added up for each of the firms. This resulted in each firm having a score on their collaboration in using communication, customization, and storage technology applications, which reflected the firm's strategic focus concerning their collaboration in using each specific supply chain technology category.

All other scale items used in the study were adapted from prior studies. These scales include relationship quality (i.e., trust and commitment) (Morgan and Hunt 1994), logistics service performance (Mentzer et al. 2001), and financial performance (Morgan and Piercy 1998). Validity of the multi-item measures was tested using M-plus (Muthen and Muthen 1998)—a structural equation modeling software. A confirmatory factor analysis was conducted to assess both discriminant and convergent validity. Factor loadings from the confirmatory factor analysis, composite reliabilities, and actual scale items appear in the Appendix B.

## Results

We used the hierarchical linear regression method for testing the hypotheses in study 1. Hierarchical regression is especially appropriate for this study because it allows for the evaluation of incremental changes in R-squared as interaction effects are entered into the models. The correlations among the variables are reported in Table 1 and the results of Study I are reported in Table 2.

Table 2 illustrates two separate models where Model 1 uses logistical service performance as the dependent variable and Model 2 uses financial performance of the retail firm. Model 1 examines the relationship between supply chain technology categories and logistical service performance in the presence of varying levels of relationship quality between retailers and their primary suppliers. The first step of Model 1 included the main effects only and the model was significant ($F$=26.96, $p$<0.01). However, only one of the three hypothesized main effects was supported (H3a). Among the three types of technology applications, collaborations in using data storage technologies provide the only positive and significant impact on logistical service performance ($b$=0.223, $p$<0.05). In the second step, the impact of interaction effects on logistical service performance were tested and the model was significant ($F$=20.10, $p$<0.01) with an adjusted $R^2$ value of 0.448. The change in $R^2$ value from Step 1 to Step 2 was also significant ($\Delta R^2$=0.07, $p$<0.01), suggesting that interaction effects significantly improved the predictive ability of the model. The results of Step 2 provide support for Hypothesis 4a and 4b as the interaction between relationship quality and communication technologies as well as the interaction between relationship quality and customization technologies were positive and significant ($b$=2.939, $p$<0.01 and $b$=3.666, $p$<0.01 respectively). However, the hypothesis (H4c) regarding the interaction effect of relationship quality and storage technologies was not supported.

Table 2 also demonstrates Model 2 where the impacts of supply chain technology collaborations on financial performance of the retail firm were examined. Once again, the first step of Model 2 involved the main effects only and the model was significant ($F$=16.99, $p$<0.01). None of the three technology types were significantly related to financial performance directly, suggesting lack of support for

**Table 1** Correlation matrix (Study 1 variables)

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Communication Tech (1) | 7.873 | | | | | |
| Customization Tech (2) | 0.883** | 4.741 | | | | |
| Data Storage Tech (3) | 0.821** | 0.677** | 7.873 | | | |
| Relationship Quality (4) | 0.053 | 0.054 | 0.012 | 5.528 | | |
| Logistics Service Performance (5) | 0.100 | 0.068 | 0.184* | 0.615 | 4.877 | |
| Relationship Financial Performance (6) | 0.139 | 0.195* | 0.109 | 0.517 | 0.404 | 4.851 |

Means are on the diagonal

*Correlation is significant at the 0.05 level (2-tailed), **Correlation is significant at the 0.01 level (2-tailed)

Listwise $N$=166

**Table 2** Hierarchical regression models

| Dependent variable | Model 1—Logistical service performance | | Model 2—Financial performance (of the firm) | |
|---|---|---|---|---|
| | Step 1 | Step 2 | Step 1 | Step 2 |
| **Direct Effects** | | | | |
| Communication Technologies (Comm) | 0.057 | 2.948*** | 0.107 | 1.338 |
| Customization Technologies (Cust) | 0.066 | 3.606*** | 0.116 | 2.408** |
| Data Storage Technologies (Stor) | 0.223** | 0.372 | 0.064 | 1.083 |
| Relationship Quality (RQ) | 0.619*** | 0.653*** | 0.506*** | .380*** |
| **Interaction Effects** | | | | |
| Comm X RQ | | 2.939*** | | 1.490 |
| Cust X RQ | | 3.666*** | | 2.237** |
| Stor X RQ | | 0.335 | | 0.880 |
| $R^2$ | 0.401 | 0.471 | 0.297 | 0.323 |
| Adjusted $R^2$ | 0.386 | 0.448 | 0.279 | 0.293 |
| $\Delta R^2$ | | 0.07*** | | 0.30*** |
| F | 26.96*** | 20.101*** | 16.99*** | 10.766*** |

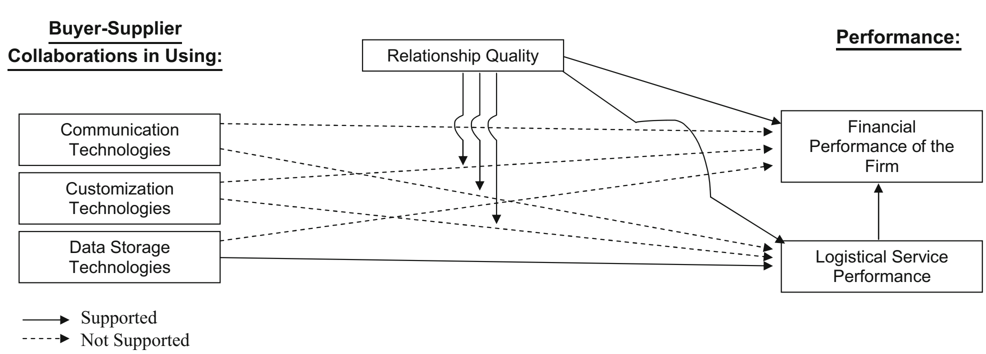
Step 1: Main effects only, Step 2: Interaction effects

hypotheses 1b, 2b, and 3b. In the second step, interaction effects were introduced to the model which proved to be significant ($F$=10.77, $p$<0.01) with an adjusted $R^2$ of 0.293. The change in $R^2$ from Step 1 to Step 2 was also significant ($\Delta R^2$=0.30, $p$<0.01), implying that the interaction variables significantly improved the predictive ability of the model. The interaction between relationship quality and customization technologies ($b$=2.237, $p$<0.05) was positively and significantly related to financial performance of the retail firm. Hence, the results of step 2 provide support for Hypothesis 5b. However, support for hypotheses regarding other interaction effects in Model 2 were not found in our analyses. Finally, it may be relevant to note that there was a non-hypothesized but significant positive relationship between logistics service performance and financial performance ($b$=.139, $p$<0.10).

## Discussion

The results of Study I (see Fig. 1) bring clarity to some issues firms may be experiencing in evaluating both their performance and the effectiveness of their technological collaboration strategy. First, the results detail that technology itself does very little for firms in terms of focal firm performance. Only firms that heavily collaborate in using data storage technologies experience a direct and positive impact on performance and only at the logistical/operational level. Having a data focus likely gives these firms an operational advantage over competitors facilitating efficient marketing operations. Development of such an advantage might be caused by the availability of necessary data when the firm tries to get insights through data mining techniques. Firms often store large amounts of data without being clear about its future utility and use. The results of this study show that such a practice might not be completely irrational, and possibly assists firms trying to gain operational and marketing insights and enhanced logistical service performance. Still, firms with focused collaborations in using communications and customization technology do not experience a positive direct effect with either firm financial or logistics service performance. This is a problematic issue for marketing or supply chain managers

**Figure 1** Study I model results.



attempting to reach a predetermined return on technology if their firm is most heavily invested in these two areas. Ultimately, the lesson may be for them to more closely examine their relationships with their supply chain partners.

Thanks to superior relationship quality, firms can utilize supply chain technologies more effectively and efficiently which then yields superior performance. This result is interesting and has a bearing on what supply chain managers curiously often do in practice, that is, professing the importance of relationships, but continuing to examine performance in individual firm terms. As such, the metrics used in Study I only examined the focal firm's performance which discounts recent developments in the supply chain logic of partnership (or network) metric development as superior to individual firm performance metrics. Thus, using Study I as a guide, we undertook a second study to examine the financial performance of the firms' "relationships" over and above the performance of the individual firm. Such two study designs are currently widely accepted in the marketing literature, including JAMS, and help in a more comprehensive exploration of the phenomenon under study. It is possible that supply chain technology collaborations carry a very small impact on the firm's individual performance and probably carry a higher level impact on the relationship specific performance. This is the question we explored in study 2.

## Study II: collaborative technology categories, resource complementarity, and partnership performance

Similar to the previous discussion on communications technology, when it comes to supply chain partnerships one would expect a synergistic effect to exist (Bowersox and Daugherty 1995; Roy et al. 2004). In these relationships, technology has been shown to improve partnership efficiencies (Stank et al. 1999) as well as overall financial performance (Mukhopadhyay et al. 1997). The result may become a supply chain based competitive advantage if the appropriate technological collaborations are in place (DiMaggio and Powell 1983).

In examining partnership performance, we included two potential moderating effects in our model. Similar to the earlier study, we included relationship quality. In a supply chain context relationship quality must be good to experience superior performance across a partnership (Roberts and Mackay 1998). Expanding our model in Study II, we also included resource complementarity. The resource based view of the firm (RBV) stresses that technology alone cannot be a source of competitive advantage (Powell and Dent-Micallef 1997). These moderators are consistent with the integration mechanisms often examined in supply chain management (Bowersox et al. 1999).

### Supply chain based communications, customization and data storage technology and partnership performance

Communication is often the key to effective partnerships (Mohr and Sohi 1995). When it comes to the supply chain, one of the great benefits of communication technology is the ability to respond quickly to changing conditions (Clemons and Row 1992). When partners communicate across the entire supply chain, technology can assist in supporting the effectiveness of that communication (Daugherty et al. 2002). Effective communication technology can reduce costly communication errors and delays (Malone et al. 1987). It can also reduce transaction costs and the cost of collaborating (Morgan and Hunt 1994). It is therefore likely that firms that heavily collaborate in using communications technology will uncover inefficiencies that can help both partners improve. Given this support, we suggest:

> H6a: Firms that collaborate heavily in using supply chain communications technology experience superior partnership performance.

Not unlike the previous discussion on customization technology, when it comes to supply chain partnerships one would expect that both (or all) partners would be presented with the opportunity for enhanced performance (Chiou et al. 2002; Clemons and Row 1992). As partner firms across the supply chain are able to better focus on end customer needs, service performance across partners should be enhanced. Likewise, understanding the customer better should allow the firms to eliminate the duplication of tasks, streamline operations, and increase supply chain flexibility enhancing partner performance. With these issues in mind we suggest:

> H6b: Firms that collaborate heavily in using supply chain customization technology experience superior partnership performance.

While data storage has traditionally focused on a singular firm, more fluid information exchange is opening the door for enhanced data leverage across the supply chain (García-Dastugue and Lambert 2007; Kahn et al. 2006). More information can be a curse, but when it comes to the supply chain, more information can also be a blessing. More and better information can equate to the streamlining of processes and reducing service duplication. It can mean merchandising identification and categorization helping with quick customer response. Considering ultimate performance, better data can improve efficiency helping with better financial performance if the partners work in concert.

> H6c: Firms that collaborate heavily in using supply chain data storage technology experience superior partnership performance.

## Relationship quality, technology category, and partnership performance

The fact that technology can reduce the cost of collaboration signifies that technology and relationships have an interactive relationship (Clemons and Row 1993). Previous research has often examined the correlation between technology and performance and between technology and relationships. Yet many of these studies ignore the potential existence of an interaction effect. Stank et al. (1999) note that it is in stronger relationships where technology has the greatest potential to positively influence performance. More specifically and incorporating the logic for the development of Hypotheses 4 and 5, we suggest that the existence of better relationship quality has a moderating effect on the previously hypothesized relationship between technological category and performance.

> H7: Relationship quality positively moderates the relationship between partnership performance and the firm's level of collaboration in using: a) communication technologies; b) customization technologies; c) data storage technologies.

## Resource complementarity, technology application category, and partnership performance

Research supports the three technological categories as likely resources driving partnership level capabilities (Kim et al. 2006). Complementary resources are resources that combine effectively with those the firms already own (Wernerfelt 1984). Similar to relationship quality, resource complementarity has also been broadly supported as a moderator of the relationship between technology and performance and ultimately effective management (Amit and Shoemaker 1993; Dierickx and Cool 1989; Teece 1986). Technological complementarity is suggested to mean that firms have similar or consistent roles, goals (Lusch and Brown 1996), and preparedness for using technology across the partnership (Kyriakopoulos and Moorman 2004). There is some RBV based evidence that complementarity of resources among alliance partners leads to alliance performance through the development of idiosyncratic resources for the alliance that cannot be duplicated by competition (Lambe et al. 2002). Since RBV suggests that complementarity of resources across partnerships supports organizational and partner performance, it is logical to expect that a similar relationship would exist given inclusion of a specific category of technology (Barney 1991). The question is: do all three technology application categories require a significant level of resource complementarity?

Kim et al. (2006) find that the relationship between technology and performance in the supply chain is quite complicated. They support the contention that the relationship is not direct and that a resource perspective must be taken. It has been specifically suggested that firms are often able to maximize operational efficiency and effectiveness only in instances of resource complementarity (Tosi and Slocum 1984). Extending their discussion, we offer our three collaborative technology application categories and the moderating impact of resource complementarity. Certainly, the complementarity of resources could improve the firms' technologically influenced performance.

> H8: Resource Complementarity positively moderates the relationship between the financial performance (of the relationship) and the firm's level of collaboration in using: a) communication technologies; b) customization technologies; c) data storage technologies.

## Sample design and data collection

Study II was conducted among retailers throughout the USA. The sample for the study was obtained through the Zoomerang zSample online panel.[2] Previous research shows that the use of internet panels is effective and in turn does not add a significant negative effect to the data (e.g. Dennis 2001; Pollard 2002). The panel participants were limited to retailers' senior marketing managers or supply chain managers involved in the implementation and management of supply chain technology. A total of 2,639 such qualified respondents could be identified in the Zoomerang panel and all of them were contacted eliciting participation in the study.

To conduct the survey, an e-mail message was sent from Zoomerang to all the potential respondents inviting them to take an online survey. The message informed them that the subject of the survey was supplier-retailer relationships, and that 75 Zoomepoints were to be awarded as incentive to those who completed the survey.[3] As in Study I, four waves were conducted to obtain the responses to the survey. Zoomerang monitors respondents' participation patterns very closely, and respondents are limited in the number of surveys they may take during a given year. On average, the panel respondents complete four surveys per year. Despite measures taken by Zoomerang to ensure respondent quality, it was still probable that some "yea sayers" (Schwab 1999) may have responded with a mere motivation to collect points. Hence, further screening of responses was conducted to eliminate respondents who marked the same scale point (method factor) throughout the survey. Twenty-one out of the 402 completed surveys were eliminated as a

[2] Details can be seen at http://info.zoomerang.com/zsample.htm

[3] Zoomepoints are part of an incentive program through which panelists are awarded products and cash for responding to surveys

**Table 3** Correlation matrix (Study 2 variables)

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Communication Tech (1) | 3.086 | | | | | |
| Customization Tech (2) | 0.859 | 1.908 | | | | |
| Data Storage Tech (3) | 0.776 | 0.766 | 3.086 | | | |
| Relationship Quality (4) | 0.168 | 0.185 | 0.150 | 5.323 | | |
| Resource Complementarity (5) | 0.215 | 0.217 | 0.215 | 0.519 | 4.802 | |
| Relationship Financial Performance (6) | 0.220 | 0.187 | 0.187 | 0.485 | 0.558 | 4.615 |

Means are on the diagonal

*N*=371 All correlation coefficients are significant at the *p*=0.05 level

result, providing 371 usable responses (18.05 % usable response rate).

Measures and psychometric analysis

In Study II, four of the six constructs were measured using the same scales/methods as Study I. These include collaborations in using communication, customization, and data storage technologies as well as relationship quality (i.e. trust and commitment). One main difference in Study II was the use of the buyer-supplier relationship as the proxy of financial performance rather than the overall financial performance of the focal firm. Financial performance of the relationship was measured by asking the respondents to characterize their level of growth on six financial variables as a result of their relationship with their primary supplier (See Nijssen 1999). Respondents are asked to note the primary supplier they buy the most from in terms of dollar volume. Finally, the resource complementarity scale was adapted from Sarkar et al.'s (2001) study of strategic alliance performance. A confirmatory factor analysis was conducted to assess construct validity. Factor loadings from the confirmatory factor analysis, composite reliabilities, and actual scale items appear in Appendix B.

Results

For consistency in testing the hypotheses in Study II, hierarchical linear regression was once again the analytical procedure of choice because of its ability to evaluate the incremental changes in R-squared as interaction effects are entered into the models. The correlation matrix for Study 2 variables is reported in Table 3 and the results of Study 2 are reported in Table 4.

Table 4 illustrates results of the hierarchical regression model where the impacts of supply chain technology categories on financial performance of the partnership were examined. The first step of the model involved the main effects only and the model is significant ($F$=43.61, $p$< 0.01). Collaboration in using communication technologies

**Table 4** Hierarchical regression models

| Dependent variable | Financial performance (of the performance) | |
|---|---|---|
| | Step 1 | Step 2 |
| **Independent variables** | | |
| Communication Technologies (Comm) | 0.172** | 0.682 |
| Costumization Technologies (Cust) | 0.100 | 1.356*** |
| Data Storage Technologies (Stor) | 0.004 | 0.432 |
| Relationship Quality (RQ) | 0.264*** | 0.322*** |
| Resource Complementarity (RC) | 0.406*** | 0.332 |
| **Interactions** | | |
| Comm X RQ | | 0.962** |
| Cust X RQ | | 1.612** |
| Stor X RQ | | 0.335 |
| Comm X RC | | 0.031 |
| Cust X RC | | 0.036 |
| Stor X RC | | 0.822** |
| $R^2$ | 0.374 | 0.403 |
| Adjusted $R^2$ | 0.365 | 0.385 |
| $\Delta R^2$ | | 0.29*** |
| F | 43.607*** | 22.050*** |

*N*=371

*$p$<.10, **$p$<.05, ***$p$<.01

is the only one among the three technology types that is significantly related to financial performance of the partnership directly, suggesting support for Hypothesis 6a and lack of support for Hypotheses 6b and 6c. In the second step, interaction effects are introduced to the model which proved to be significant ($F$=22.05, $p$<0.01) with an adjusted $R^2$ of 0.385. The change in $R^2$ from Step 1 to Step 2 is also significant ($\Delta R^2$=0.030, $p$<0.01), implying that the interaction variables significantly improved the predictive ability of the model. The interaction between relationship quality and customization technologies ($b$= 1.612, $p$<0.05) is positively and significantly related to financial performance of the partnership as well as the interaction between relationship quality and communication technologies ($b$=0.962, $p$<0.05). Hence, the results of step 2 provide support for Hypothesis 7. In addition, the interaction between resource complementarity and data storage technologies is also ($b$=0.822, $p$<0.05) positively and significantly related to financial performance of the partnership, partially supporting Hypothesis 8. Support for hypotheses regarding interaction effects between resource complementarity and customization and communications technologies were not found in our analyses (see Fig. 2).

Discussion

Study II improves upon Study I by examining the impact of firms most heavily collaborating in using one of the three technological application categories and adjusting the outcome variable to one focused on the performance of the supply chain partnership. Additionally, we included resource complementarity in the analysis as the sharing of matched resources is evidenced as vital to partnership performance (Hunt and Morgan 1995). Similar to Study I, only one of the technological application categories had a direct impact on performance. When it comes to financial performance of the partnership, collaborations in using communications technologies seem to be the superior strategy. This is likely due to the importance of firm-to-firm communications in facilitating supply chain relationships (Mohr and Nevin 1990).

Given the extant research supporting relationship quality and resource complementarity as vital to partnership performance, it was expected that important interaction effects would be uncovered. Those predictions for the most part were correct. Confirming study 1, relationship quality had a positive and significant effect on firms that choose to collaborate in using both communication and customization technologies when we examined the financial performance of the relationship. Importantly, managers who have not developed better relationships with their partners would be ill advised when collaborating most heavily in using customization technologies and communication technologies until partner relationships have been improved.

Study II shows that this may be largely due to resource complementarity. Having resources that can extend across firms may facilitate the effective usage of data and the technology that drives it. As such it is suggested that data storage collaborations positively impact financial performance of the relationship only when complementary resources—such as ability to analyze and/or mine the stored data properly—exist. This is not the case for communications and customization collaborations—likely due to a greater interactive focus on the customer.

Ultimately, Study II sheds light on how the supply chain should be measuring technological collaboration performance and likely performance as a whole. The impact of the collaboration in using supply chain technology goes beyond the individual firm. Ignoring this fact could damage the viability of the partner firm(s) or undervalue the potential benefits of an underperforming technological collaboration when examined only at the focal firm level. Thus, managers and academics alike are encouraged to adopt supply chain spanning metrics when studying performance across partners and networks of firms.

## Implications of the studies

This study was predicated on the importance of technology, resources and relationships in a supply chain management

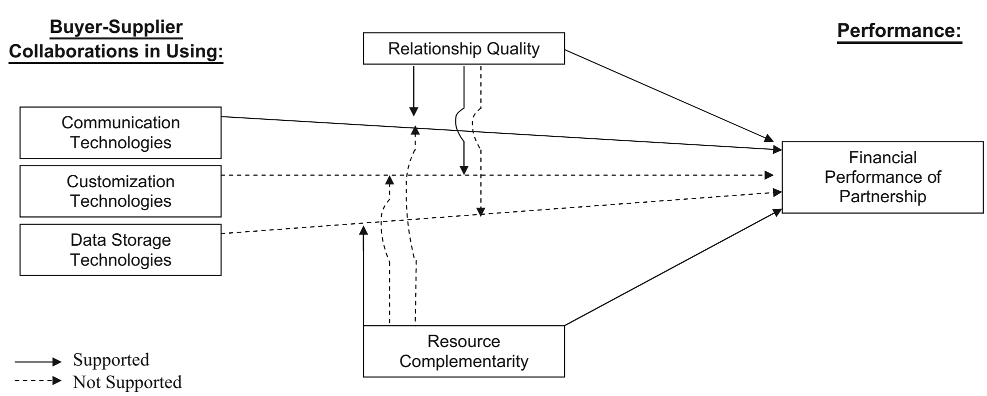



**Figure 2** Study II model results.

context. Supply chain management and marketing are closely intertwined as can be evidenced in our discussion of existing research. Since collaborative use of technology is of growing importance in marketing strategy (Rust and Espinoza 2006), we adopted it into this study of firm-to-firm technological application categories to show a tactical and strategic interconnection between supply chain management technology and marketing. All too frequently, research from each specific discipline ignores recent discoveries by other fields and thus overlooks opportunities for a cross-fertilization of ideas and ultimately —better research. Researchers should take note of the importance of both the deployment of market based resources and the impact of supply chain technology when they examine firm strategy in today's partner driven technology intensive environment. These perspectives could impact many existing areas of research whether the focus is supply chain management, operations management, services marketing, retailing, consumer behavior, or consumer psychology.

Researchers like Kettinger et al. (1994) have found that many firms experience negative results individually and with their channel partners when attempting to implement technology across organizations. Others have found quite the opposite while focusing specifically on performance and specific technologies rather than a technological collaboration strategy (Angeles and Nath 2001; Rogers et al. 1993). Additionally, most of the supply chain and marketing technology research to date has examined one specific technology (i.e. EDI) or one category of technology (i.e. communications technology). This study encompasses eighteen technologies and gives insights into how examinations of similar technologies and technological strategy may precede in marketing and supply chain management. Hopefully future research and managerial decision making will give more emphasis to strategic investments in technology, relationships, and complementary resources.

As researchers and managers alike better understand how firm-to-firm collaborations use the three categories of supply chain technology impact performance, they may begin to make goal driven investments. Our results openly support that technology impacts performance in different ways and through different associations. It is therefore suggested that both managers and researchers consider what technological category they are collaboratively investing in and what outcome they should examine given both the firm's strategy and that of its partners. When relationships are weaker it may be appropriate to focus on data storage technologies. This approach will likely improve logistics service performance, but will only have an impact on the partners as a whole if the resources across the partners are complementary. Thus, this approach is not advisable if the relationship does not involve complementarity resources. If managers hope to positively influence financial performance or logistical service performance at the firm level through communications or customization collaborations in technology, they will have to be sure that they have high quality relationships that are based on trust and commitment are in place. This is also true if they hope to maximize the financial performance of the relationship. Ultimately, the "across the board" suggestion may be to develop superior partner relationships before pursuing any significant collaborative investments in supply chain technology.

The study also shows that firms cannot go it alone in most cases if they hope to reap positive results in terms of technologically influenced financial performance. When attempting to maximize both firm and partner performance it is suggested not only that the quality of the relationship between the partners be examined, but also that the metrics around performance be chosen with a supply chain perspective in mind. In total, this study highlights the importance of relationship quality in assisting technology in influencing superior partner based performance if that technology is not data storage technology. This is consistent with the relationship marketing and supply chain relationship literature that suggests relationships across partners almost always matter. Future models should include relationship quality if the benefits of supply chain technology are to be completely understood.

## Limitations and future research

As with many exploratory studies, this research has some limitations that should be expanded upon in future research. First, we only focused on retailers in our study. This required the retailers to report the effectiveness of the entire supply chain. Future approaches should extend to second, third, and network partners to examine more dynamic effects across the actual supply chain. Additionally, like many studies, the data are cross sectional. A longitudinal study could assist in accounting for relational changes over time as well as the introduction, implementation, and decline of supply chain technologies. It should also be noted that the respondents in the study were US based only, so generalization to international markets may be difficult. Using this study as a starting point, we hope future researchers extend this perspective to global markets.

This study is important to future research due to the ever increasing infusion of technology into nearly every marketing and supply chain business activity. Future research also should develop a more specific understanding of which complementary resources are most effective across issues of retailing, wholesaling, manufacturing, new product development, segmentation, and many other areas. One such complementary resource maybe a firm's ability to mine and/or analyze the acquired and stored data. Therefore, future research should consider a firm's ability to analyze and/or mine data as a possible moderator for the data storage—performance relationship. Marketing channels and supply chain management researchers should consider confirming the role of other relationship management and marketing constructs in our exploratory framework. Retailing and services marketing researchers could also test the technology application categories at the consumer interface. This would be valuable as all marketing activity ends with the consumer. Lastly, future research should also focus on developing a more exhaustive approach to technological classification. Due to the need for recognizing the highly integrative and seamless nature of technologies in co-creation of value, our classification is not "mutually exclusive" and hence has room for improvement. In conclusion, the examination of collaboration strategies in supply chain technologies seems expansive and it is our hope that this study Will assist in some way in creating a starting point for future research.

## Appendix A

Summary of Technologies

| Technology | Definition | Primary use | Secondary use |
|---|---|---|---|
| Automated materials handling equipment | Automating the material handling operations. | Increase in productivity, reduced cost of material handling. | Increase in storage capacity. |
| Automatic replenishme nt systems | An exchange relationship in which the seller replenishes or restocks inventory based on actual product usage and stock level info provided by the buyer | Reduced commitment to inventory holdings. | Generates valuable market related data, Increased sales, Higher selling space productivity. |
| Capacity resource planning | Capacity planning —a process to predict the types, quantities, and timing of critical resource capacities that are needed within an infrastructure to meet accurately forecasted workloads. | Reduce excess inventory levels. | Shorter lead times. Improved customer service. |
| CRM systems | A process designed to grasp features of customers and apply those features to marketing activities. | Greater customer loyalty. | Lower marketing costs Mutual learning and strategic cooperation. |
| Distribution resource planning | A planning philosophy which permits the planning of all resources within a distribution firm including business planning, marketing/sales, procurement, logistics, distribution requirements and financials. It is an integrated approach to scheduling delivery and controlling inventory for a logistics system. | Effective and efficient deployment of finished goods inventories throughout the often complex distribution network. Better coordination between marketing and manufacturing. Reduction of freight cost, distribution cost, lower inventories. | Improved service levels. Better obsolescence control. Forward feasibility in planning promotion. |
| Electronic data interchange (EDI) | The electronic transfer from computer to computer of commercial or administrative transactions using an agreed standard to structure the transaction or message data | Speed and accuracy of data transmission. | Enlarged operational efficiency. Better customer service. Improved trading partner relationships. Increased ability to compete (Indirect uses) |
| Enterprise resource planning (ERP) | Configurable information system packages that integrated information and information based processes within and across functional areas in an organization. | Integrate business functions. Allow data to be shared across company. | Greater flexibility and efficiency. Information available just in time for decisions. Timely, accurate info sharing with customers and suppliers. |
| E-Commerce | Buying, selling, or marketing on the internet. Buying and selling via digital media. Three types of technology: Sell side, buy-side, and marketplace. | Access to worldwide markets (for seller). Minimal sales costs. | Faster communication. Can compete with large firms. Improving customer service and racking customer behavior. |
| Geographic information systems (GIS) | A computer hardware and software system that stores, links, analyses, and displays geographically | Modelling supply and delivery points and product routing optimization. | Data management and reporting support for product transaction management systems. Drive time |

(continued)

| Technology | Definition | Primary use | Secondary use |
|---|---|---|---|
| | referenced information (i.e. data identified according to their geographic location). | | calculations from a central facility. Asset tracking |
| Intelligent agent purchasing systems | An intelligent agent is a computer system situated in some environment and that is capable of flexible autonomous action in this environment in order to meet its design objectives. | Reduce time and tedium. | Bargain finding, learning about user's past behavior, get information. |
| Internet/Extr anets | Extranet: It is a private network that uses the internet protocol and the public telecommunication system to securely share part of a business's information or operations with suppliers, vendors, partners, customers, and other businesses. | Extranet: Bringing together all of the extended enterprise; suppliers, partners, customers into the information loop, critical for firm's quick response and strategic movement. | Increase loyalty, commitment and confidence among customers and partners. |
| Manufacturing resource planning (MRP/MRP II) | MRPII: A method for the effective planning of all resources of a manufacturing company. It is made up of a variety of functions, each linked together; Business planning, Production planning, Master scheduling, Materials requirement planning, and Capacity requirement planning. | MRPI: Increased productivity. MRPII: Gains in productivity. Dramatic increase in customer service. | MRPI: Automatic calculation of material requirements. MRPII: Much higher inventory turns. Reduction in material costs. |
| Network management systems | A service that employs a variety of tools, applications, and devices, to assist human network managers in monitoring and maintaining computer networks. | Configuration, Accounting, Fault, Security, and Performance. | NA |
| Order management systems | Systems that receive customer order information and inventory availability from the warehouse management system and then groups orders by customer and priority, allocates inventory by warehouse site, and establishes delivery dates. | Cost effective customer order management and better customer service through the integration of CRM and SRM applications. | Optimal supplier choice. Collaborative planning with suppliers. |
| Physical distribution management systems | PDM is concerned with integration of individual efforts that go to make up the distributive function, so that a common objective is realized. Its four principal components are order processing, stock levels/inventory, warehousing, and transportation. | Improved customer service. | Cost effective physical distribution management. |
| Point of sale (POS) | At the core of POS systems are a standard-issue computers running specialized POS software, usually with a cash drawer and receipt printer, and often with a bar code scanner and credit card reader. | Streamlines the replenishment process. | The ability to get an immediate, up-to-the-minute, accurate assessment of inventory. |
| Scanners-bar codes-UPC | Gives every product a unique symbol and numeric code. The multi-digit number identifies the manufacturer and the item. Scanners can read the bars and spaces of the symbol. | Increased materials throughput speed. (Integrates the receiving function electronically with computerized purchasing, materials management, and accounts payable systems.) | Increased inventory accuracy. |
| Warehouse management systems | Implementation of advanced techniques and technology to optimize all functions throughout the warehouse. (Can also be defined as Logistics Information Systems) | Reduced costs. | Improved customer service. |

## Appendix B

Study 1—CFA, scale items, and model fit statistics

| Source citation | Scale item | Scale content | CFA factor loading |
|---|---|---|---|
| **Relationship Quality** Morgan and Hunt (1994) **Composite Reliability = .858** | Trust 1 (TR 1) | Our primary supplier is very honest and truthful. | 0.767 |
| | Trust 2 (TR 2) | ...can be trusted completely. | 0.893 |
| | Trust 3 (TR 3) | ...can be counted on to do what is right. | 0.866 |
| | Trust 4 (TR 4) | ...keeps promises it makes to our firm. | 0.854 |
| | Commitment 1 (CMT 1) | Our relationship with our supplier is one that we are very committed to. | 0.814 |
| | Commitment 2 (CMT 2) | ...very important to us. | 0.841 |
| | Commitment 3 (CMT 3) | ...one that we intend to maintain indefinitely. | 0.872 |
| | Commitment 4 (CMT 4) | ...worth our maximum effort to maintain. | 0.870 |
| Logistics service performance Mentzer et al. (2001) **Composite Reliability = .914** | Personal Contact Control 1 (PC1) | The designated contact person makes an effort to understand my situation | 0.876 |
| | Personal Contact Control 2 (PC2) | Problems are resolved by the designated contact person | 0.894 |
| | Personal Contact Control 3 (PC3) | The product knowledge/experience of contact personnel is adequate | 0.903 |
| | Order Release Quantities 1 (ORQ1) | Requisition quantities are not challenged | 0.790 |
| | Order Release Quantities 2 (ORQ1) | Difficulties never occur due to minimum release quantities | 0.814 |
| | Order Release Quantities 3 (ORQ1) | Difficulties never occur due to maximum release quantities | 0.873 |
| | Information Quality 1 (IQ 1) | Product specific information is available | 0.955 |
| | Information Quality 2 (IQ 1) | Product specific information is adequate | 0.955 |
| | Ordering Procedures 1 (OP 1) | Requisitioning procedures are effective | 0.965 |
| | Ordering Procedures 2 (OP 2) | Requisitioning procedures are easy to use | 0.965 |
| | Order Accuracy 1 (OA 1) | Shipments rarely contain the wrong items | 0.864 |
| | Order Accuracy 2 (OA 2) | Shipments rarely contain an incorrect quantity | 0.857 |
| | Order Accuracy 3 (OA 3) | Shipments rarely contain substituted items | 0.804 |
| | Order Condition 1 (OC 1) | Materials received from depots is undamaged | 0.836 |
| | Order Condition 2 (OC 2) | Materials received from vendors is undamaged | 0.754 |
| | Order Quality 1 (OQ1) | Substituted items work fine | 0.888 |
| | Order Quality 2 (OQ2) | Products ordered meet technical requirements | 0.888 |
| | Order Discrepancy Handling 1 (ODH 1) | Correction of delivered quantity discrepancies is satisfactory | 0.909 |
| | Order Discrepancy Handling 2 (ODH 2) | The report of discrepancy process is adequate | 0.922 |
| | Order Discrepancy Handling 3 (ODH 3) | Response to quantity reports is satisfactory | 0.919 |
| | Timeliness 1** (TIME 1) | Time between placing orders and receiving delivery is short | 0.858 |
| | Timeliness 2** (TIME 2) | Delivers arrive on the date promised | 0.922 |
| | Timeliness 3** (TIME 3) | The amount of time a requisition is on back-order is short | 0.786 |
| Financial performance Morgan and Piercy (1998) **Composite Reliability = .877** | Financial peformance 1 (FIN 1) | Current Average Profits Per Customer | 0.929 |
| | Financial Peformance 2 (FIN 2) | Current ROI | 0.947 |
| | Financial Peformance 3 (FIN 3) | Sales growth | 0.933 |

Fit Statistics: CFI .93; TLI .93; RMSEA .06

## Appendix B (continued)

STUDY 2—CFA, scale items, and model fit statistics

| Source citation | Scale item | Scale content | CFA factor loading |
|---|---|---|---|
| **Relationship Quality** Morgan and Hunt (1994) **Composite and Reliability = .941** | Trust 1 (TR 1) | Our supplier id very honest and truthful. | 0.914 |
| | Trust 2 (TR 2) | ...can be trusted completely. | 0.912 |
| | Trust 3 (TR 3) | ...can be counted on to do what is right. | 0.936 |
| | Trust 4 (TR 4) | ...keeps promises it makes to our firm. | 0.915 |
| | Commitment 1 (CMT 1) | Our relationship with our supplier is one that we are very committed to. | 0.909 |
| | Commitment 2 (CMT 2) | ...very important to us. | 0.897 |
| | Commitment 3 (CMT 3) | ...one that we intend to maintain indefinitely | 0.925 |
| | Commitment 4 (CMT 4) | ...worth our maximum effort to maintain. | 0.897 |
| **Resource Complementary** Sarkar et al. (2001) **Composite and Reliability = .916** | Resource Complementary 1 (RC 1) | We need each others resources to accomplish our goals | 0.855 |
| | Resource Complementary 2 (RC 2) | The resources contributed are significant in achieving our mutual goals | 0.931 |
| | Resource Complementary 3 (RC 3) | Resources brought into the relationship by each firm are very valuable for each other | 0.916 |
| | Resource Complementary 4 (RC 4) | Our supplier brings to the table resources and competencies that complement our own | 0.918 |
| | Resource Complementary 5 (RC 5) | Strategically, we couldn't ask for a better fit between my firm and our supplier | 0.842 |
| **Financial Performance of the Partnership** Nijssen (1999) **Composite Reliability = .933** | Financial Performance 1 (FIN 1) | Gross profit achieved by the relationship | 0.926 |
| | Financial Performance 2 (FIN 2) | Sales revenue achieved by the relationship | 0.941 |
| | Financial Performance 3 (FIN 3) | Production economies achieved by the relationship | 0.936 |
| | Financial Performance 4 (FIN 4) | Effects of relationship on your market share | 0.888 |
| | Financial Performance 6 (FIN 6) | Overall economic benefits of the relationship | 0.903 |

Fit Statistics: CFI .94; TLI .94; RMSEA .05

## References


Amit, R., & Shoemaker, P. J. (1993). Strategic assets and organizational rent. *Strategic Management Journal, 14*(1), 33–46.

Angeles, R., & Nath, R. (2001). Partner congruence in Electronic Data Interchange (EDI)-enabled relationships. *Journal of Business Logistics, 22*(2), 109–127.

Ansari, A., & Mela, C. F. (2003). E-customization. *Journal of Marketing Research, 40*(2), 131–145.

Armstrong, J. S., & Overton, T. S. (1977). Estimating non-response bias in mail surveys. *Journal of Marketing Research, 14*(3), 396–402.

Ballou, R. H., & Masters, J. M. (1999). Facility location commercial software survey. *Journal of Business Logistics, 20*(1), 215–233.

Barney, J. B. (1986). Organizational culture: can it be a source of sustained competitive advantage? *Academy of Management Review, 11*(3), 656–665.

Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120.

Bolton, R. N., Smith, A. K., & Wagner, J. (2003). Striking the right balance. *Journal of Service Research, 5*(4), 271–291.

Bowersox, D. J. (1989). Editorial. *The Journal of the Academy of Marketing Science, 17*(1), 51–52.

Bowersox, D. J., Closs, D. J., & Stank, T. P. (1999). *21st century logistics: Making supply chain integration a reality.* Michigan State University: Council of Logistics Management.

Bowersox, D. J., & Daugherty, P. J. (1995). Logistics paradigms: the impact of information technology. *Journal of Business Logistics, 16*(1), 65–80.

Bucklin, R. E., & Gupta, S. (1999). Commercial use of UPC scanner data: Industry and academic perspectives. *Marketing Science, 18* (3), 247–273.

Chiou, J., Wu, L., & Hsu, J. C. (2002). The adoption of form postponement strategy in a global system: the case of Taiwanese information technology industry. *Journal of Business Logistics, 23*(1), 107–124.

Christensen, C. M., Johnson, M. W., & Rigby, D. K. (2002). Foundations for growth. *MIT Sloan Management Review, 43*(3), 22–31.

Clemons, E. K., & Row, M. C. (1992). Information technology and industrial cooperation: the changing economics of coordination and ownership. *Journal of Management Information Systems, 9* (2), 9–28.

Clemons, E. K., & Row, M. C. (1993). Limits to interfirm coordination through information technology: results of a field study in consumer package goods industry. *Journal of Management Information Systems, 10*(1), 73–95.

Closs, D. J., & Savitskie, K. (2003). Internal and external logistics information technology integration. *International Journal of Logistics Management, 14*(1), 63–76.

Coff, R. W. (2002). Human capital, shared expertise, and the likelihood of impasse in corporate acquisitions. *Journal of Management, 28*(1), 107–128.

Cunningham, P., & Joshi, A. W. (2002). Winning market leadership: Strategic market planning for technology-driven business. *The Journal of the Academy of Marketing Science, 30*(1), 87–88.

Daugherty, P. J., Myers, M. B., & Richey, R. G. (2002). Information support for reverse logistics: the influence of relationship commitment. *Journal of Business Logistics, 23*(1), 85–106.

Day, G. S. (1994). The Capabilities of market-driven organizations. *Journal of Marketing, 58*(4), 37–52.

Day, G. S. (2006). Achieving advantage with a service dominant logic. In R. F. Lusch & S. L. Vargo (Eds.), *The service-dominant logic of marketing: Dialog, debate, and directions*, pp. 85–90. Armonk, NY: M.E. Sharp.

Dennis, J. M. (2001). Are internet panels creating professional respondents? *Marketing Research, 13*(2), 34–38.

Dewan, R., Jing, B., & Seidmann, A. (2003). Product customization and price competition on the internet. *Marketing Science, 49*(8), 1055–1070.

Dierickx, I., & Cool, K. (1989). Asset stock accumulation and the sustainability of competitive advantage: Reply. *Management Science, 35*(12), 1514–1514.

DiMaggio, P., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review, 48*, 147–160.

Flint, D. J., & Mentzer, J. T. (2006). Striving for integrated value chain management given a service-dominant logic for marketing. In R. F. Lusch & S. L. Vargo (Eds.), *The service-dominant logic of marketing: Dialog, debate, and directions*, pp. 139–149. Armonk, NY: M.E. Sharpe.

García-Dastugue, S. J., & Lambert, D. M. (2007). Interorganizational time-based postponement in the supply chain. *Journal of Business Logistics, 28*(1), 57–81.

Gilmore, J. H., & Pine, J. B,. I. I. (1997). The four faces of mass customization. *Harvard Business Review, 75*(1), 91–101.

Grazin, K. L., & Kahn, K. B. (1989). Consumer logistics: Conceptualization, pertinent issues and a proposed program of research. *The Journal of the Academy of Marketing Science, 17*(1), 91–101.

Gronroos, C. (1995). Relationship marketing: the strategy continuum. *Journal of the Academy of Marketing Science, 23*(4), 252–254.

Gwinner, K. P., Bitner, M. J., Brown, S. W., & Kumar, A. (2005). Service customization through employee adaptiveness. *Journal of Service Research, 8*(2), 131–148.

Hernández-Espallardo, M., & Arcas-Lario, N. (2003). The effects of authoritative mechanisms of coordination on market orientation in asymmetrical channel relationships. *International Journal of Research in Marketing, 20*, 133–152.

Hogan, J., Lemon, K., & Rust, R. T. (2002). Customer equity management: charting new directions of the future of marketing. *Journal of Services Research, 5*(1), 4–12.

Hunt, S. D., & Morgan, R. M. (1995). The comparative advantage theory of competition. *Journal of Marketing, 59*(1), 1–15.

Hunt, S. D., & Morgan, R. M. (2005). The resource-advantage theory of competition: A review. In N. Malhotra (Ed.), *Review of marketing research-I*, pp. 153–201. New York: ME Sharpe.

Kahn, B. E. (1998). Dynamic relationships with customers: high-variety strategies. *Journal of the Academy of Marketing Science, 26*(1), 45–53.

Kahn, K. B., Maltz, E. N., & Mentzer, J. T. (2006). Demand collaboration: effects on knowledge creation, relationships and supply chain performance. *Journal of Business Logistics, 27*(2), 191–221.

Kettinger, W. J., Grover, V., Guha, S., & Segars, A. H. (1994). Strategic information systems revisited: a study in sustainability and performance. *MIS Quarterly, 18*(1), 31–58.

Kim, D., Cavisgil, S. T., & Calantone, R. J. (2006). Information system innovations and supply chain management: channel relationships and firm performance. *Journal of the Academy of Marketing Science, 34*(1), 40–54.

Kyriakopoulos, K., & Moorman, C. (2004). Tradeoffs in marketing exploitation and exploration strategies: the overlooked role of market orientation. *International Journal of Research in Marketing, 21*, 219–240.

Lambe, C. J., Spekman, R. E., & Hunt, S. D. (2002). Alliance competence, resources, and alliance success: conceptualization, measurement, and initial test. *Journal of the Academy of Marketing Science, 30*(2), 141–158.

Lusch, R. F., & Brown, J. R. (1996). Interdependency, contracting, and relational behavior in marketing channels. *Journal of Marketing, 60*(4), 19–38.

Lusch, R. F., & Vargo, S. L. (2006). Service-dominant logic as a foundation for a general theory. In R. F. Lusch & S. L. Vargo (Eds.), *The service-dominant logic of marketing: Dialog, debate, and directions*, pp. 406–419. Armonk, NY: ME Sharpe.

Lusch, R. F., Vargo, S. L., & O'Brien, M. S. (2007). Competing through service: insights from service-dominant logic. *Journal of Retailing, 83*(1), 5–18.

Malone, T. W., Yates, J., & Benjamin, R. I. (1987). Electronic markets and electronic hierachies. *Communications from the ACM, 30*(6), 484–497.

Mentzer, J. T., Gomes, R., & Krapfel, R. E. (1989). Physical distribution service: a fundamental marketing concept? *Journal of the Academy of Marketing Science, 17*(1), 53–62.

Mentzer, J. T., Flint, D. J., & Hult, G. T. M. (2001). Logistics service quality as a segment-customized process. *Journal of Marketing, 65*(4), 82–104.

Mohr, J., & Nevin, J. R. (1990). Communication strategies in marketing channels: a theoretical perspective. *Journal of Marketing, 54*(4), 36–51.

Mohr, J., & Sohi, R. S. (1995). Communications flows in distribution channels: impacts on assessments of communications quality and satisfaction. *Journal of Marketing, 71*(4), 393–416.

Morash, E. A., & Lynch, D. F. (2002). Public policy and global supply chain capabilities and performance: a resource-based view. *Journal of International Marketing, 10*(1), 25–51.

Morgan, N., & Piercy, N. (1998). Interactions between marketing and quality at the SBU level: influences and outcomes. *Journal of the Academy of Marketing Science, 26*(3), 190–208.

Morgan, R. M., & Hunt, S. D. (1994). The commitment trust theory of relationship marketing. *Journal of Marketing, 58*(3), 20–38.

Mukhopadhyay, T., Rajiv, S., & Srinivasan, K. (1997). Information technology impact on process output and quality. *Management Science, 43*(12), 1645–1659.

Muthen, L. K., & Muthen, B. O. (1998). *Mplus: The comprehensive modeling program for applied researchers*. Los Angeles, CA: Muthen and Muthen.

Nijssen, E. J. (1999). Success factors of line extensions of fast-moving consumer coods. *European Journal of Marketing, 33*(4), 450–469.

Olavarrieta, S., & Ellinger, A. E. (1997). Resource-based theory and strategic logistics research. *International Journal of Physical Distribution and Logistics Management, 27*(9/10), 559–587.

Parasuraman, A., & Grewal, D. (2000). The impact of technology on the quality-value- loyalty chain: a research agenda. *Journal of the Academy of Marketing Science, 28*(1), 168–174.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal, 14*(3), 179–191.

Pollard, W. E. (2002). Use of consumer panel survey data for public health communication planning: an evaluation of survey results. *American Statistical Association 2002 Proceedings of the Section on Health Policy Statistics*, 2720–2724.

Powell, T. C., & Dent-Micallef, A. (1997). Information technology and competitive advantage: the role of human, business, and technology resources. *Strategic Management Journal, 18*(5), 375–405.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review, 68*(3), 79–91.

Priem, R. L., & Butler, J. E. (2001). Is the resource-based "view" a useful perspective for strategic management research? *Academy of Management Review, 26*(1), 22–40.

Richey, R. G., Daugherty, P. J., & Roath, A. S. (2007). Firm technological readiness and complementarity: capabilities impacting logistics service competency and performance. *Journal of Business Logistics, 28*(1), 195–228.

Rinehart, L. M., Cooper, B. M., & Wagenheim, G. M. (1989). Furthering the integration of marketing and logistics through customer service in the channel. *The Journal of the Academy of Marketing Science, 17*(1), 63–71.

Roberts, B., & Mackay, M. (1998). IT supporting supplier relationships: the role of electronic commerce. *European Journal of Purchasing and Supply Management, 4*(2/3), 175–184.

Rogers, D. S., Daugherty, P. J., & Stank, T. P. (1993). Enhancing service responsiveness: the strategic potential of EDI. *Logistics Information Management, 6*(3), 27–32.

Roy, S., Sivakumar, K., & Wilkinson, I. F. (2004). Innovation generation in supply chain relationships. *Journal of the Academy of Marketing Science, 31*(1), 61–79.

Rust, R. T., & Espinoza, F. (2006). How technology advances influence business research and marketing strategy. *Journal of Business Research, 59*(10–11), 1072–1078.

Rust, R. T. (1997). The dawn of computer behavior: interactive service marketers will find their customer isn't human anymore. *Marketing Management, 6*(3), 31–33.

Rust, R. T. (2001). The rise of e-service. *Journal of Service Research, 3*(4), 283–284.

Rust, R. T., & Kannan, P. K. (2002). *E-service: new directions in theory and practice*. Armonk, NY: M.E. Sharpe.

Sarkar, M. B., Echambadi, R., Cavusgil, S. T., & Aulakh, P. S. (2001). The influence of complementarity, compatibility, and relationship capital on alliance performance. *Journal of the Academy of Marketing Science, 29*(4), 358–375.

Schwab, D. P. (1999). *Research methods for organizational studies*. Mahwah, NJ: Lawrence Erlbaum Associates.

Song, M., Di Benedetto, A. C., & Mason, R. W. (2007). Capabilities and financial performance: the moderating effect of strategic type. *Journal of the Academy of Marketing Science, 35*(1), 18–34.

Srivastava, R. K., Shervani, T. A., & Fahey, L. (1998). Market-based assets and shareholder value: a framework for analysis. *Journal of Marketing, 61*(1), 2–17.

Stank, T., Crum, M., & Arango, M. (1999). Benefits of interfirm coordination in food industry supply chains. *Journal of Business Logistics, 20*(2), 21–41.

Sundaram, S., Schwartz, A., Jones, E., & Chin, W. W. (2007). Technology use on the front line: how information technology enhances individual performance. *Journal of the Academy of Marketing Science, 35*(1), 101–112.

Teece, D. J. (1986). Transactions cost economics and the multinational enterprise: an assessment. *Journal of Economic Behavior & Organization, 7*(1), 21–45.

Tosi, H. L., & Slocum, J. W. (1984). Contingency theory: some suggested directions. *Journal of Management, 10*(1), 9–26.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing, 68*(1), 1–17.

Varki, S., & Rust, R. T. (1998). Technology and optimal segment size. *Marketing Letters, 9*(2), 147–167.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171–180.

Wind, Y. (1978). Issues and advances in segmentation research. *Journal of Marketing Research, 15*(3), 317–337.

Waller, M. A., Dabholkar, P. A., & Gentry, J. J. (2000). Postponement, product customization, and market-oriented supply chain management. *Journal of Business Logistics, 21*(2), 133–159.