Information sharing and collaboration practices in reverse logistics

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Abstract
Purpose – The purpose of this study is to investigate how the use of information technology (IT) and supply chain management initiatives (information sharing and collaboration) impact a company's performance in reverse logistics (RL).
Design/methodology/approach – A survey based on a previous exploratory research and literature review was sent out to 600 US companies having substantial activities in RL. Issues addressed in the survey, such as IT types deployed, IT operational attributes, information sharing, and collaboration, involve multiple parties in multi-tier RL networks, extending beyond a simple buyer-supplier dyad.
Findings – The results revealed that the type of IT used *per se* did not have a differential impact on a company's performance in RL. However, IT operational attributes positively affected RL performance and information sharing and collaboration are critical to RL performance.
Practical implications – Investment in IT alone cannot improve a company's performance; managers should take full account of IT attributes when deciding IT in RL. IT operational attributes tend to support one another – an improvement in one would lead to improvements in the others. With no exception in RL, companies need to share information and collaborate with their partners.
Originality/value – The paper reports an empirical survey of the IT use and collaboration practices in RL, and provides insights into the relationships and impacts of IT, RL operational attributes, information sharing, and collaboration on one another as well as on RL performance.

Keywords Information exchange, Communication technologies, Supply chain management

Paper type Research paper

1. Introduction

A supply chain is a complex network that consists of suppliers, manufacturers, distributors, retailers, and end customers, working together to convert raw materials to work-in-process inventory (WIP) to final products. The major material flow is forward from suppliers to manufacturers to distributors to retailers; the forward logistics is the focus of most research supply chain management (SCM) (Prahinski and Kocabasoglu, 2006). On the other hand, the reverse material flow from customers back to suppliers, the so-called reverse logistics (RL), also plays an important role in SCM, due to product returns and sustainability issues (Rogers and Tibben-Lembke, 1999; van Hoek, 1999; Defee *et al.*, 2009).

RL is "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Rogers and Tibben-Lembke, 1999, p. 2). A typical RL process is as follows (Li and Olorunniwo, 2008): once returns are accepted, the firm issues a return merchandise authorization or return material authorization (RMA) to begin all RL activities. Returned products with less damage are processed to put back to finished goods inventory with some test and repair, to be sold to customers. The rest with more damage is returned to suppliers, sold to secondary markets, dismantled to harvest components, or landfilled.

Owing to high asset value involved and unique characteristics of RL processes, firms must develop RL related capabilities: handling return operations, managing information technology (IT), sharing information, and collaborating with partners. Handling return operations means that firms are able to manage all RL activities from the consumption point to the origin point. Nowadays all managers rely on IT to store data, communicate with data, share information, and make informed decisions. Information sharing and collaboration are in the spirit of SCM.

This study seeks to investigate how the use of IT and SCM initiatives (information sharing and collaboration) impacts a company's performance in RL. Specifically, the paper examines:
- The current IT types used in RL and their differential impact on RL performance.
- Operational attributes that derive from IT use and their impact on RL performance.
- The extent of collaboration and information sharing in RL and their impact on RL performance.

Note that the issues in (1) to (3) above cover and involve multiple parties in multi-tier RL networks extending beyond a buyer-supplier dyad.

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2. Literature review

Main activities of RL include product returns, remanufacturing, source reduction, material substitution, and waste management (Rogers and Tibben-Lembke, 1999, 2001). RL is critical to overall corporate success: RL can be used as a competitive strategy, a profit center, an asset recovery hub, and a tool to improve customer satisfaction (Ritchie *et al.*, 2000; Li and Olorunniwo, 2008). RL also brings extensive impacts on human health and environment, and thus enhance a firm's citizenship (Murphy and Poist, 2003; Li and Olorunniwo, 2008, Defee *et al.*, 2009).

However, much research is exploratory and descriptive in nature (e.g. Rogers and Tibben-Lembke, 1999, 2001; Li and Olorunniwo, 2008); there is a need of explanatory research for identifying structural relationships in RL performance. Moreover, the focal point of most research is the firm itself, overlooking interrelationships with its supply chain partners (e.g. Rogers and Tibben-Lembke, 1999, 2001). How SCM initiatives (information sharing and collaboration) affect RL performance is still not clear.

2.1 IT in RL

In general, IT is a necessary infrastructure for both the company itself and its supply chain partners. However, whether the choice of a particular IT type differentially affects a company's performance as desired is not clear. Heavy IT investment does not necessarily improve companies' productivity – this is the so-called productivity paradox of IT (e.g. Brynjolfsson, 1993; Hitt and Brynjolfsson, 1996; Anderson *et al.*, 2003).

Though IT is critical to SCM, the adoption and use of IT in SCM also falls short of expectation. Many technologies are more costly and complex than previously thought: electronic data interchange (EDI), radio frequency identification (RFID), and internet marketplaces (Wang *et al.*, 2007; Lau, 2007). In addition, IT adoption is complicated with various supply chain factors: information sharing, collaboration, and integration. Information sharing is discouraged by different IT systems used by different companies: different data formats, software, etc. Collaboration and integration may require that a company can view and change its partners' database. A common phenomenon in practice is "Old computers go into museums, but old software goes into production every night" (Kanet, 1998). In many cases, we upgrade our hardware many times, but core software remains same.

Daugherty *et al.* (2002) studied three distinct dimensions of information systems (IS) support in RL: capability, compatibility, and technologies. IS capability means accuracy and availability of information, IS compatibility refers to how easy it is to use, and IS technologies include automated material handling equipment, bar codes, EDI, and radio frequency. They concluded no relationship between IS support and RL performance, while they conjectured that this finding was due to short-term nature of performance and erratic RL demands.

2.2 Information sharing and collaboration in RL

The ability to collaborate with various players in the reverse chain is as important as in the forward chain. In fact, what makes a forward supply chain successful is the collaboration, visibility, and trust of the various entities in the chain. This is also true for the reverse chain, especially since RL process is also heavily demand driven – that is, the downstream customers make the final decision in orders and returns.

Collaboration in a supply chain occurs when "two or more independent companies work jointly to plan and execute supply chain operations with greater success than when acting in isolation" (Simatupang and Sridharan, 2003). Collaboration can also be defined as a relationship between independent firms "characterized by openness and trust where risks, rewards, and costs are shared between parties" (Sandberg, 2007). Ganesan (1994) posited that trust alludes to the extent to which supply chain partners perceive each other to be credible (i.e. partners have expertise to perform effectively) and benevolent (i.e. partners have intentions and motives that will benefit the relationship). Information exchange on the other hand is the extent to which data is accessible to partner firms through mutually agreed exchange infrastructure. Information sharing among supply chain partners is an important prerequisite for effective collaboration (Yu *et al.*, 2001; Sandberg, 2007).

There seems to be increased attention on collaborative efforts in forward flow supply chains in the last decade based on the assumed premise that closer inter-firm relationships and enhanced information exchanges do improve the quality of decision-making, reduce uncertainty, and consequently improve supply chain performance (Whipple and Russell, 2007). Supply chain performance is perceived to be improved, due to collaborative activities, in several other areas such as reduced inventory, reduced costs, improved customer service, improved forecasts, and timely deliveries (Waller *et al.*, 1999; Daugherty *et al.*, 2002; Whipple and Russell, 2007).

In a recent work by Whipple and Russell (2007), three types of collaborative relationships were identified, namely: Type I, Type II, and Type III. Type I refers to collaborative transaction management characterized by high-volume data exchange (e.g. use of EDI for VMI and scorecard collaborative initiatives) and task alignment centered on operational tasks. Type I relationships focus on transaction management with emphasis on IT tools, building data integrity, and standardizing the information that is exchanged. Type II refers to collaborative event management characterized by joint planning and decision-making activities such as in new product introductions/new store openings, new business plans, and sales promotions where there are more interpersonal interactions across collaborating firms. Type II activities involve both initial collaborative planning, forecasting, and replenishment (CPFR) activities and event collaboration, requiring non-transactional data. Type III, collaborative process management, involves joint problem solving, long-term process planning, and more fully integrated supply chain processes such as manufacturing scheduling, truckload utilization, warehouse management, and order forecasts/replenishment. Here, collaborative process management requires building trust, setting joint business goals, and designing inter-enterprise processes to meet those goals (Whipple and Russell, 2007). Sandberg (2007) observed that the use of joint processes in collaboration partnerships is very low, with only 24 percent of the respondents in his survey admitting having jointly planned processes.

Since most firms that engage in forward supply chain activities may also have RL operations (see Li and Olorunniwo, 2008), it is likely that some aspects of the issues raised above in forward supply chains will also be applicable to RL.

3. The model

Our research model is illustrated in Figure 1. RL performance including satisfaction and profitability is the dependent variable; independent variables consist of IT use, IT operational attribute, information sharing, and collaboration.

Four sets of hypotheses are examined in this paper, deriving from the model illustrated in Figure 1. We shall examine if the adoption and use of any particular type of IT will have any differential impact on performance (satisfaction and profitability). Since the mid-level manager is interested in the operational (day to day) efficiency gains, it is appropriate to understand how such efficiency gains through use of IT translates into performance gains. Thus, for handling return operations, we will explore how IT's enabling effect of such operational attributes - speedy RMA, effective RL integration, effective RL planning, effective RL operations, efficient product tracking, information sharing inside the company – translates into performance gains. The last two sets of hypothesis will be the impact of information sharing and collaboration on RL performance.

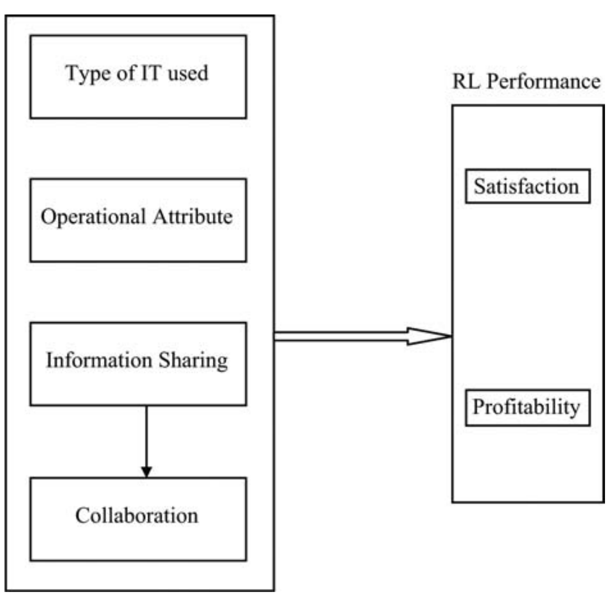
3.1 Type of IT used

Our first hypothesis is derived assuming that there is no correlation between an individual IT use and RL performance. In particular, we study IT use in SCM including three major components – the backbone of logistics information systems, communication systems, and execution systems (e.g. Bowersox *et al.*, 2007; Murphy and Wood, 2008). The backbone includes enterprise resource planning (ERP) systems and legacy systems; communications include EDI, internet, satellite, bar code and scanning, and radio-frequency data communication; execution systems consist of warehouse management systems, transportation management systems, customized solutions integrating with ERP, and stand alone customized solutions:

H1. Adoption and use of any particular IT type has no differential impact on RL performance.

The rationale for the first hypothesis lies in the observation that IT, considered as enablers of operational and collaborative initiatives, cannot by itself guarantee superior performance. It is important to consider managerial (organizational, relational, and human resource) issues along with IT to have any differential impact (Michelino *et al.*, 2008).

Figure 1 Research model



3.2 Operational attributes and RL performance

The handling of reverse flows can contribute to the corporate image because the efficiency and effectiveness of the RL operations can promote longer-term inter-firm relationships, higher customer satisfaction ratings, and higher corporate profitability (Daugherty *et al.*, 2002). Consider, for example three of the operational attributes examined here: speedy RMA, effective integration with the whole supply chain, and efficient product tracking.

3.2.1 RMA

Notice that the returns process begins when the manufacturers or retailers accept products back from their customers after issuing an RMA based on the returns policy. In other words, the whole process is buyer-driven. Then, these returned products are typically shipped back by a third-party logistics provider (3PL) to a returns processing facility, where employees perform all necessary operations in order to salvage most value from returns. Note RMA is shared by all partners in this multi-tier network (e.g. manufacturer, retailer, customer, 3PL).

3.2.2 Coordination and tracking

Inter-firm coordination and collaboration is almost impossible if not preceded by intra-firm coordination through information sharing. Many researchers agree that IT reduces the cost associated with intra-firm coordination by reducing inventory buffers, underutilized capacity, obsolescence, and lost sales (e.g. Garcia-Dastugue and Lambert, 2003). This is more so in the RL environment, which is characterized by uncertainty in return volume, frequency, and source, and thus necessitates accurate product tracking and rapid timing/processing. All firms in the network can access same tracking information and coordinate thereafter.

From the foregoing, our second hypothesis assumes the positive relationship between IT operational attributes and a company's performance in RL:

H2. Operational attributes are positively related to RL performance.

3.3 Information sharing and collaboration

Sharing of information between firms (Type I collaborative transaction management in Whipple and Russell, 2007) has long been recognized as a competitive weapon that enhances firm performance (Closs *et al.*, 1997; Daugherty *et al.*, 2005; Whipple and Russell, 2007). The type of information shared typically include production planning, inventory levels/turns (e.g. in VMIs), fill rate, forecast accuracy, promotion performance, price levels and pricing, sales data, and on-time delivery (Sandberg, 2007; Whipple and Russell, 2007). Such information exchange enhances operational efficiency in RL (e.g. speedy RMA and product tracking) and provides greater supply chain visibility, which can in turn lead to cost reductions, improved in-stock performance, increased sales, and improved customer satisfaction of the returns turnaround process. Information sharing has also been recognized to be an important prerequisite for effective collaboration (Yu *et al.*, 2001; Sandberg, 2007).

Collaboration (Type II and Type III, according to Whipple and Russell, 2007) generates similar benefits as does Type I, but to a greater degree. Because of greater commitment, joint ownership of processes, and trust between partners, the mutual benefits derived from this type of collaboration is sustained over a long-term horizon. The causal direction: "information sharing results in collaboration" or "collaboration results in information sharing" is subject to argument. It has been shown that strong collaborative process relationships increase the likelihood that companies will exchange more critical information required to further enhance more collaborative supply chain strategies. On the other hand, an intensive information sharing could force the firms involved to specify their collaboration in terms of a process in order to be able to more efficiently use the information shared (Derocher and Kilpatrick, 2000; Mentzer *et al.*, 2000; Sandberg, 2007). However, as noted in Sandberg (2007) and Whipple and Russell (2007), collaboration on the operational/transactional level (i.e. information sharing) is the most commonly subscribed form of collaboration and the degree of strategic collaborative activity (Type II and III) in practice is very low. Thus, it can be conjectured that most companies start sharing information first. As time goes on and trust level is built up, firms may gradually escalate the relationship toward joint strategic process building. Thus, the relationship: "Information sharing results in collaboration" may be the practice (see Figure 1). The foregoing discussions lead us to examine the following hypotheses:

H3a. Information sharing leads to greater collaboration in RL.
H3b. Information sharing leads to greater RL performance.
H4. Collaboration leads to greater RL performance.

4. Survey sample and data collection

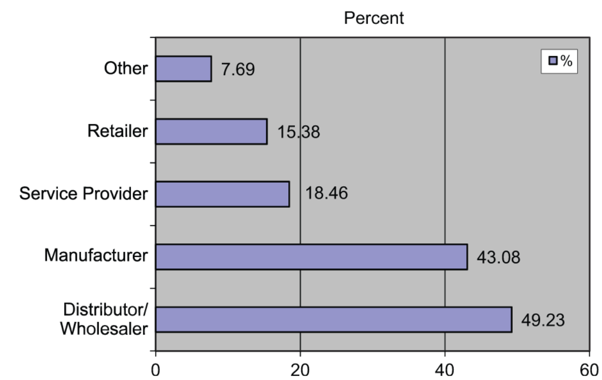
In preparation, we visited three companies and conducted in-depth interviews with their managers (Li and Olorunniwo, 2008). The survey instrument was developed on these results and extensive literature review on academic journals and trade magazines. The questionnaire was subsequently pretested by four people – two from academe and two from industry.

The company list is comprised of 594 companies of Automotive Aftermarket Industry Association, AAIA Member Directory, which encompasses all repairs and services of vehicles after the original sale. In fall 2007, each company's contact person of AAIA was received a cover letter, a questionnaire, and a self-addressed stamped return envelope. The cover letter explained the purpose of this RL research, and asked the recipient to pass to the most qualified person when necessary. Three weeks after the first mailing, we sent a reminder to those non-respondents. We received 57 answered questionnaires and 38 undeliverable, and the return rate is about 10 percent. In spring 2008, we went to a local logistics society meeting in middle Tennessee, introduced our research, and then received eight returned questionnaires; so a total of 65 useable questionnaires were utilized for our analysis.

We asked managers four sets of questions: IT use, operational attributes due to IT use, information sharing and collaboration, and performance. All data are analyzed in SPSS 15. Figure 2 shows that the majority of the respondents are either distributors (49.2 percent) or manufacturers (43.08 percent).

Also, about 85.94 percent of the firms have fewer than 500 employees, 4.69 percent have 500-1,000, and 6.25 percent have 1,001-5,000 employees. Asked to provide information as to whether the same employees handle both forward and return flow activities, 84.62 percent of the respondents answer in the affirmative.

Figure 2 Position of responding firms in the supply chain

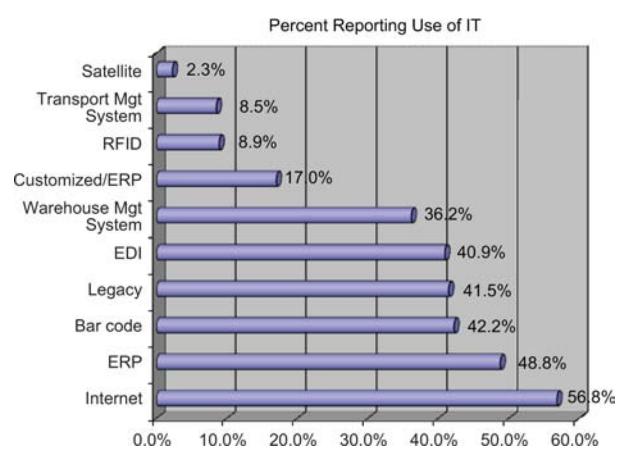


5. Analysis and results

The respondents were asked to indicate whether or not they deployed these technologies listed in Figure 3 in their returns processing. Of those that provided a response to each IT presented, internet was the highest used technology, 56.8 percent. Fairly used include ERP (48.8 percent), bar code (42.2 percent), legacy system (41.5 percent), and EDI (40.9 percent). Few used customized solution integrating with ERP, radio-frequency data communication system, and transportation management system, while very few used satellite. Due to low usages of satellite, radio-frequency data communication, transportation management, and customized solution integrating with ERP, we will not analyze these IT uses on RL performance.

For all the hypotheses examined in this paper, RL performance was assessed using two scorecards: satisfaction with RL operations and profit margin from RL operations. Respondents were asked to express their satisfaction with how their facilities handle their returns. A seven-point Likert scale is used, where 1 = very dissatisfied and 7 = very satisfied. The response averaged 5.35 with a standard deviation 1.40, indicating that respondents are fairly satisfied. On the other hand, a seven-point Likert scale is used to solicit input from respondents as to the level of profit margin derived form their

Figure 3 Types of IT used in RL



RL operations: 1 = ≤0 percent, 2 = 0.1-5 percent, 3 = 5.1-10 percent, 4 = 10.1-20 percent, 5 = 20.1-30 percent, 6 = 30.1-40 percent, and 7 = over 40 percent. The average response is 2.40 with a standard deviation 1.16; it shows the profit from RL is positive but rather moderate.

5.1 Hypothesis *H1*

We performed series of one-way ANOVA analysis to test hypothesis *H1*. In each case, the dependent variable was either satisfaction or profit margin, while the treatment of each independent variable has two levels: 1 (the particular IT is used) and 0 (IT is not used). No ANOVA result indicated any statistically significant difference between usage and non-usage. Thus *H1* is supported.

5.2 Operational attributes and hypothesis *H2*

Operational attributes refer to the impact that IT use in general has on the returns processing operations. Respondents were asked to evaluate to what extent they agree/disagree to the fact that the stated operational effectiveness/efficiency was gained. Operational attributes engage multiple partners in the RL network. A Likert scale 1-5 was used for all attributes, where 1 = strongly disagree and 5 = strongly agree. The descriptive statistics are summarized in Table I.

Overall feedback indicated that these attributes were just fine, between neural (3) and partially agree (4). The best attribute was to obtain RMA speedily, while worst was integration with the whole supply chain system. The correlations among these IT attributes are provided in Table I. All are positive and significant at 0.01 level (two-tailed test). It means operational attributes tend to support each other. For example, if a company plans RL effectively, it is likely that the company also has effective operations.

We then performed factor analyses on these six operational attributes using principal component extraction. Only one component has initial eigenvalue greater than one, 4.53; this factor explains 75.453 percent total variance. Table I details the factor loading (numbers on the diagonal shown in italics). We conclude that one factor well represents all six IT attributes.

The reliability of these six operational attributes was measured with Cronbach's α (Cronbach, 1951); Cronbach's α of these attributes is valued at 0.933, indicating sufficient reliability (DeVellis, 1991). So, these attributes have internal consistency and we can form a summated scale from them. This summated variable, called operational attributes, was obtained by calculating the mean of all six IT attributes. The summated operational attributes variable has a mean 3.41 and a standard deviation 1.08.

5.3 Information sharing and collaboration

After an extensive search of trade and academic literature, we developed items that would be of interest to most practitioners and academia on information sharing and collaboration in RL. Information sharing and collaboration in RL occur in the context of a multi-tier network, beyond a buyer-supplier dyad. For example, the use of web-enabled inventory may involve manufacturer, retailer, customer, and 3PL. Again, we included items that may fall under both Type I (collaborative transaction management) and Types II and III (collaborative issues that address trust, joint process planning, etc) as presented in Whipple and Russell (2007). Respondents were asked to rate the effectiveness of items presented (see Table II) using a Likert scale 1-5 where 1 = poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent. The descriptive statistics are summarized in Table II. Results show that respondents rate information sharing and collaboration between fair and good.

Next, we performed factor analyses using principal component extraction with Varimax rotation. We obtained two components with initial eigenvalues greater than one: component one has initial eigenvalue 6.837 explaining 62 percent total variance and component two has initial eigenvalue 1.11 explaining 10 percent total variance. Table II presents detailed rotated component matrix, ordered in decreasing magnitude of the factor loading within each factor. Component one clearly relates to collaboration items (type II and III), including long-term alliance, trust, well defined objectives, scope, and responsibilities, joint forecast and planning, sharing of risk and reward, joint-established performance measure, and accuracy of shared information. Component two clearly relates to information sharing items (type I), including warehouse information sharing, mutual access to databases, web-enabled inventory data sharing, and amount of cost data sharing.

We also obtained Cronbach's α of these seven collaboration items, 0.921, indicating high internal consistency. We then built a summated scale by calculating the mean of seven collaboration items: long-term alliance, trust, well defined collaborative objectives, joint forecast and planning, sharing of risk and reward, joint-established performance measure, and accuracy of shared information. This summated variable is called collaboration, with a mean 2.83 and a standard deviation 0.934.

The Cronbach's α of the four information sharing items is 0.904, demonstrating sufficient reliability. Another summated variable, called information sharing, was also calculated by taking the mean of these four information sharing items, warehouse information sharing, mutual access to databases,

Table I Correlations, means, standard deviations and factor loadings for operational attributes

	Mean	Standard deviation	Efficient product tracking	Effective operations	Effective planning	Effective integration	Speedy RMA obtainment	Information sharing
Efficient product tracking	3.41	1.262	*0.921*					
Effective operations	3.48	1.191	0.811	*0.908*				
Effective planning	3.25	1.21	0.743	0.845	*0.893*			
Effective integration	3.13	1.28	0.796	0.727	0.691	*0.880*		
Speedy RMA	3.64	1.207	0.685	0.700	0.658	0.636	*0.825*	
Information sharing within company	3.54	1.321	0.701	0.522	0.554	0.630	0.649	*0.776*

Note: Italic entries: factor loading

Supply Chain Management: An International Journal
Volume 15 · Number 6 · 2010 · 454–462

Table II Descriptive statistics and factor loadings for information sharing and collaboration items

	Mean	Standard deviation	Factor 1	Factor 2
Warehouse information we both share	2.16	1.16	0.255	0.856
Mutual access to our and our partners' databases	2.19	1.12	0.339	0.806
The use of web-enabled inventory data that we share	2.26	1.23	0.335	0.796
The amount of cost data we share with our partner	2.28	1.21	0.282	0.795
Long-term alliance with our partners	3.44	1.07	0.881	0.158
Trust between us and our partners	3.17	1.05	0.880	0.252
Well defined collaborative objectives, scope, and responsibilities	2.84	1.16	0.765	0.387
Joint forecast and planning arrangements	2.30	1.16	0.712	0.490
Sharing of risk and reward with our partners	2.29	1.25	0.668	0.510
Joint-established performance measures	2.38	1.01	0.649	0.441
Accuracy of information shared with our partners	3.13	1.03	0.519	0.465

web-enabled inventory data sharing, and amount of cost data sharing. Information sharing has a mean 2.19 and a standard deviation of 1.05.

Hypotheses *H2, H3a, H3b*, and *H4*:

H2. Operational attributes are positively related to RL performance.
H3a. Information sharing leads to greater Collaboration in RL.
H3b. Information sharing leads to greater RL performance.
H4. Collaboration leads to greater RL performance.

Figure 4 shows the regression analyses with performance as dependent variable and the summated scales, for operational attributes, information sharing, and collaboration, taken one at a time, as independent variable. Note that the independent variable in each of the simple linear regressions is one of operational attributes, collaboration, and information sharing, which are summated variables (i.e. averages of several variables). Empirical research works often use summated variables that are derived from Likert scales, and consequently treat these summated variables essentially as scale variables. K-S tests of normality are confirmed (at $p = 0.05$) for these summated variables with p-values of 0.546 (operational attributes), 0.082 (information sharing), and 0.394 (collaboration). We also conducted normal P-P plot analyses of regression standardized residual, which indicate good normality of our regression results. The three hypotheses relating to RL performance: *H2*, *H3b* and *H4* were confirmed when satisfaction was the RL performance variable used. However, when profit margin is the RL performance variable, *H2* is not confirmed while *H4* is marginally confirmed at $p < 0.10$.

While profit margin measures only monetary value, satisfaction covers broad dimensions: customer loyalty, sustainable development, and healthy environment. We argue that satisfaction is a more appropriate performance measurement in RL, because for most companies RL is a small portion of business and earning profit is not the sole purpose of RL activities. We conclude that operational attribute, information sharing, and collaboration all positively contributes to RL performance.

6. Managerial implications and conclusions

This paper examines the IT types used in RL and their differential impact on RL performance. It looked at the operational attributes that derive from IT use and their impact on RL performance. It also examines the importance and extent of information sharing and collaboration in RL and their impact on RL performance.

In addition to showing the various IT types that are commonly used in RL, our results reveal that there is no correlation between a particular IT usage and RL performance. In order words, no particular IT usage leads itself to better RL performance. As our findings also show, IT as a necessary component provides the potential to improve RL performance, but such performance improvement is a function of IT attributes, rather than IT per se. Thus, our results offer one explanation to the productivity paradox of IT in the literature.

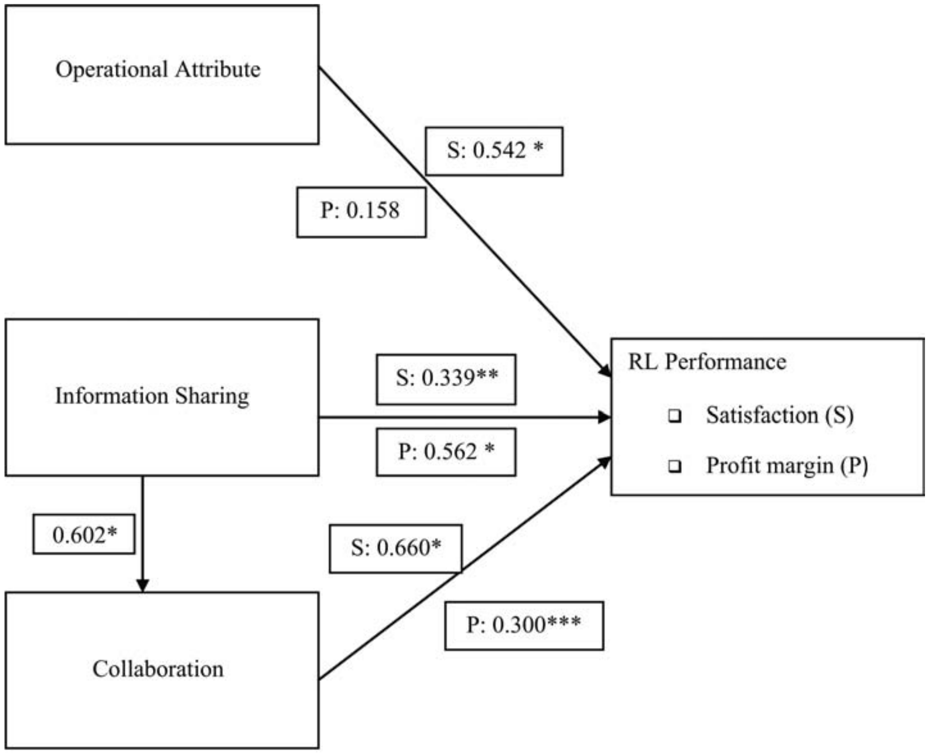
A more important issue that mangers may note is that to invest in IT successfully, companies must consider RL contexts. Managers should not think IT as technology alone. It is critically important to consider managerial (organizational, relational, and human resource) issues along with IT to have any differential impact (Michelino *et al.*, 2008). Also, managers should ask whether the IT investment can improve RL operational attributes, such as efficient tracking and effective planning. This observation is quite relevant, considering that companies use a huge variety of different technologies and new technology evolves dynamically.

Our findings demonstrate that operational attributes tend to support each other – an improvement in one would lead to improvements in others. Thus, for example, if a company plans RL effectively, it is likely the company also would have effective operations. This domino effect is quite an encouraging finding for any RL manager- improving in one area of the attributes can have a positive effect on the others, thus allowing the managers to provide needed justification to upper management to invest greater efforts in RL operations.

While improved operational attributes creates a perception of greater satisfaction in the RL operations, the respondents indicate that they do not necessarily result in greater profits for the firm. Since satisfaction measured here is the perception of those in charge of the operations, it is conceivable that the appropriate information of the actual bottom line may not reflect this perception. Although the profit is the bottom-line of a business, we argue that employee satisfaction of the RL process is a more subtle way to eventually achieve profitability. Indeed, the concept of the "service profit chain" should be remembered here. Basically, the principle links ultimate profitability to employee satisfaction. Thus, if RL operational employees are satisfied with the process, they create service value which would increase customer's perceived value of their RL service product.

Supply Chain Management: An International Journal
Volume 15 · Number 6 · 2010 · 454–462

Figure 4 Regression analyses (beta values shown) for hypotheses *H2, H3a, H3b*, and *H4*



Key: * Significant at $p < 0.01$; ** significant at $p < 0.05$; *** significant at $p < 0.10$

In this case for example, the speed and accuracy of RL processing may impact customer loyalty that may eventually lead to profitability. Thus, RL managers may henceforth cease to view RL as necessary evil (costs, in most instances).

Our results also show that information sharing leads to greater collaboration in RL and directly (by itself) leads to greater RL performance. Collaboration also leads to greater RL performance. A lesson here for managers is that RL operatives should realize that information sharing is usually the first critical step in SCM and involves intense data exchange. As time goes on and trust level is built up, firms may gradually escalate the relationship toward joint strategic process building. Good information sharing improves supply chain visibility that can lead to better coordination and build a solid foundation for collaboration in efficient operations, cost reduction, and customer service perfection.

Collaboration built on high-quality information sharing is essential to superior RL performance. The ultimate goal of any RL manager is to eventually reach a relationship stage with strategic business partners that involve CPFR as well as collaborative process management. This later stage involves joint problem solving, long-term process planning, and more fully integrated RL processes such as manufacturing scheduling, truckload utilization, and warehouse management. Here, collaborative process management requires building trust, setting joint business goals, and designing inter-enterprise processes to meet those goals. Although it is not an easy goal to reach, companies could strive to develop well defined collaborative objectives, establish joint performance measures, share risk and reward with partners, extend trust between partners, and construct alliance with partners.

7. Recommendations for future research

One drawback of our study is the limited survey sample mostly in automobile industry in the US. One extension is to examine other industries as well. We may find some correlations and reveal some trends across industries. It may be true that certain industries tend to have more complex and advanced IT systems and adopt new technologies early, while others keep IT investment minimal due to some industry-wide characteristics. The second extension is to conduct a set of longitudinal studies that measures IT use and performance changes over a certain period, investigating the cause-effect relationship and their development over time. Will early adopters in RL IT have performance advantage in the long run? Or, companies should apply a "wait and see" strategy, delaying the adoption of the technology till most others have done so? Can a huge investment in the short term (e.g. ERP) save the company money in the long term? Lastly, we may apply a web-based survey to attract more responses from more regions. Respondents from different countries can conveniently answer the questionnaire as long as they can access the internet.

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Appendix

Figure A1 Questions used in the analysis

1. How satisfied are you with how your facilities handle your returns flows?

Very Dissatisfied	Moderately Dissatisfied	Marginally Dissatisfied	Neutral	Marginally Satisfied	Moderately Satisfied	Very Satisfied
1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐

2. Use of Information technology (IT): Which types of IT do you deploy for your returns processing? (Check all that apply)

Backbone of logistics information systems	☐ Enterprise Resource Planning (ERP) system ☐ Legacy system
Communication systems	☐ Electronic Data Interchange (EDI) ☐ Internet ☐ Satellite ☐ Bar code and scanning ☐ Radio-frequency data communication
Execution systems	☐ Warehouse Management System ☐ Transportation Management System ☐ Customized solution integrating with ERP ☐ Stand alone customized solution

3. Please evaluate your IT system as it impacts your returns processing operations

SD = Strongly Disagree; PD = Partially Disagree; N = Neutral; PA = Partially Agree; SA = Strongly Agree

	SD	PD	N	PA	SA
Enables information sharing with all facilities inside the company	☐	☐	☐	☐	☐
Enables returned material authorization (RMA) to be obtained speedily	☐	☐	☐	☐	☐
Enables planning RL effectively	☐	☐	☐	☐	☐
Enables effective daily RL operations	☐	☐	☐	☐	☐
Effectively integrates with my whole supply chain system	☐	☐	☐	☐	☐
Enables us to efficiently track products	☐	☐	☐	☐	☐

4. How would you rate the quality and effectiveness of the information sharing and collaboration arrangements that you have with your partners (i.e. suppliers, customers, and service providers)?

	Poor	Fair	Good	Very Good	Excellent
Accuracy of information shared with my partners	☐	☐	☐	☐	☐
Mutual access to our and our partners' databases	☐	☐	☐	☐	☐
The amount of cost data we share with our partner	☐	☐	☐	☐	☐
The use of web-enabled inventory data information that we share	☐	☐	☐	☐	☐
Warehouse information we both share	☐	☐	☐	☐	☐
Trust between us and our partners	☐	☐	☐	☐	☐
Long-term alliance with our partners	☐	☐	☐	☐	☐
Well defined collaborative objectives, scope, and responsibilities	☐	☐	☐	☐	☐
Joint forecast and planning arrangements	☐	☐	☐	☐	☐
Jointly-established performance measures	☐	☐	☐	☐	☐
Sharing of risk and reward with our partners	☐	☐	☐	☐	☐

1. What is your profit margin (net income divided by revenues, or net profits divided by sales) from the RL operations?

☐ ≤ 0% ☐ 0.1-5% ☐ 5.1-10% ☐ 10.1-20% ☐ 20.1-30% ☐ 30.1-40% ☐ Over 40%

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