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Decision Support Variables for Reverse Logistics

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ABSTRACT

The purpose of this study is to discover variables that should be considered in the creation of a strategic knowledge and decision support system for reverse logistics. This paper addresses a gap in the Lambert model of supply chain management through refining the link between the returns management process and the overall strategy of a supply chain firm by addressing the decision as to which reverse logistics activity to pursue. Current literature is sparse in this area and existing DSS do not specifically address this problem. In order to determine what variables should be considered in such a system, recent reverse logistics frameworks which address returned-products disposition were reviewed. Using an inductive literature review process and subsequent content analysis, the authors found seven factors that are relevant to reverse logistics disposition. Propositions are offered for further research in this area.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U.S. Government.

Keywords

Decision support, knowledge management, information management, reverse logistics

INTRODUCTION

In the United States, reverse logistics (RL) is a multi-billion dollar business (Stock, Speh and Shear, 2002). Accordingly, the decisions made within this area can significantly affect a firm's bottom line. In order to assist industry decision makers and academicians alike, researchers and practitioners work to create knowledge and decision support systems in order to aggregate decision parameters and assist managers in making the rather unstructured decisions presented by reverse logistics. One such decision involves how to recover the greatest amount of value from a returned product. This decision explores which disposition option will generate the most value for the firm, given its environment and circumstances. Research suggests that end-of-life product disposition can take four forms: a product can be reused, upgraded (remanufactured, refurbished, etc.), recycled, or disposed of (Prahinski and Kocabasoglu, 2006; Rogers, Lambert, Croxton and Garcia-Dastugue, 2002; Staikos and Rahimifard, 2007). What knowledge should be available to the organization in order to maximize this decision is not clearly understood, however. This lack of knowledge creates an inability to consider the best form of disposition, how to use this decision to improve existing forward and reverse logistics processes, and how to best support logistics process improvements. In order for a decision support system to be built that facilitates this and other RL decisions, a clear understanding of what is used within organizations as knowledge in this context must be developed.

The disposition decision is strategic in nature. However, the link between organizational strategy and RL processes has not been widely explored. The Lambert model of supply chain management conceptually integrates many business processes across the supply chain (Croxton, Garcia-Dastugue, Lambert and Rogers, 2001; Lambert, Cooper and Pagh, 1998). The processes that are managed throughout this entire supply chain are: customer relationship management, supplier relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, product development and commercialization, and returns management. However, research that ties the returns management process into the strategic objectives of the supply chain is limited. Although some research investigates strategic and operational considerations for pursuing returns management activities (Rogers et al., 2002), the actual framework outlining these considerations has not been comprehensively investigated. Furthermore, supply chain specific knowledge and decision frameworks in the literature are sparse and the factors used vary considerably (Carter and Ellram, 1998; Dowlatshahi, 2005; Jayaraman and Yadong, 2007; Mollenkopf, Russo and Frankel, 2007; Rogers et al., 2002; Skinner, Bryant and Richey, 2008; Tan and Kumar, 2006). Research is needed in this area to determine what factors must be evaluated from a strategic perspective when deciding whether or not to pursue or how to improve the reverse logistics process. Only when these variables are identified and thoroughly investigated will an understanding of the knowledge needs of the organization be attained and the creation of a DSS for this purpose be possible.

This review investigates RL framework literature as it applies to the product disposition decision within RL. The purpose of this review is to identify and assimilate the knowledge required for effective RL decision-making that exists in the contemporary literature in order to create better understanding of the factors that affect the decision and offer propositions for future research. The outcome of this review identifies the knowledge variables considered within the scope of the literature. This provides insight into what variables should be included in a strategic DSS to facilitate disposition decisions.

METHODOLOGY AND SCOPE

This review examines the existing RL disposition framework literature to provide insight as to what strategic considerations a firm should make when determining what RL activities to employ. To realize this purpose, articles which offer any type of disposition decision framework were sought for review. The criterion for a usable article was simple and explicit: the paper must offer some sort of framework which addressed RL disposition. Although a rather broad parameter, an exhaustive search for such literature yielded very few results.

To begin, a search of applicable literature was conducted. Using Gibson and Hanna's (2003) article regarding logistics journal usefulness as a starting point, the top logistics journals were searched. Each of the top ten journals identified by their review, as depicted in Table 1, was searched.

1. Journal of Business Logistics	6. Traffic World
2. Harvard Business Review	7. Intl Journal of Phys Dist/Log Mgt
3. Supply Chain Mgt Review	8. Journal of Supply Chain Mgt
4. Transportation Journal	9. Journal of Commerce
5. Intl Journal of Logistics Mgt	10. Journal of Inbound Logistics

Table 1: Top Journals in Supply Chain Management

These journals were searched via electronic database. Keyword search terms were: reverse logistics, closed loop, returns, disposition, framework, end of life, model, and decision. The scope of this review in regard to range of dates was limited only by the start date, which was 1998. This date was chosen as this was the year of Carter and Ellram's (1998) initial framework publication. Their comprehensive search of the RL literature revealed no other such framework before that time. Although numerous articles were retrieved and reviewed by the authors for adherence to criteria, this process yielded just eight usable articles.

In an attempt to find more usable articles, the authors then turned to the journals of additional disciplines. RL is discussed in many of the operations management journals; therefore, the top journals in this field were searched using the same criteria as above. Understanding that fewer articles are likely to be found in these journals which meet the criteria, the top 20 operations management journals were searched. In rank order in accordance with the findings of Gorman and Kanet (2005), these journals are listed in Table 2.

1. Transportation Science	11. Logistics and Trans Review
2. Mathematics and Ops Research	12. Annals of Ops Research
3. Operations Research	13. European Journal of Ops Research
4. Manufacturing/Service Ops Mgt	14. Journal of Supply Chain Mgt
5. Management Science	15. Naval Research Logistics
6. IIE Transactions	16. Intl Journal of Production Research
7. Production and Ops Mgt	17. IEEE Transactions on Eng Mgt
8. Journal of Scheduling	18. Journal of Business Logistics
9. Interfaces	19. Decision Sciences
10. Journal of Ops Mgt	20. Production Planning and Control

Table 2: Top Journals in Operations Management

The Journal of Business Logistics and the Journal of Supply Chain Management were not re-investigated. Although many search results were yielded in this process, only two usable articles were found.

In a final attempt to find more literature which met the criteria, the authors conducted a broad search of business journals utilizing the “search by subject” function in the university’s electronic library database to find appropriate electronic databases to search. This led to a search of the Business Source Premier and ABI/Inform databases. Using the same keyword searches generated a variety of additional articles. However, only three more additional articles met the criteria of this review.

In sum, the exhaustive search only yielded 13 articles which met the criteria established by the authors. However, these articles represent the core research surrounding disposition decision making and the authors feel that, although lacking in quantity, the richness of these articles allow for an adequate review of the literature.

In order to determine which factors may be pertinent for inclusion in a DSS, the articles were first thoroughly reviewed to determine what enduring concepts were prevalent in the selection of articles. The authors determined that the enduring concepts throughout this review were encompassed by the following seven general categories: supply chain and manufacturing considerations, costs associated with RL, market considerations, customers, profits associated with RL, environmental concerns, and regulatory concerns. In turn, the 13 articles were again reviewed using these categories as a basis for content analysis. This content analysis served to validate the significance of the seven factors.

Limitations

This review includes only articles which the authors believe offer some sort of framework which addresses RL disposition. Adherence to this criterion led to the omission of many quantitative articles which may also offer insight into which variables may be important to consider. Further, articles which meet the criteria of this review may have been missed in the initial keyword search. Finally, the inductive nature of discovering key variables may have led to the omission of additional factors that should be considered.

LITERATURE REVIEW

A variety of internal and external forces drive a firm’s selection of a disposition alternative. Building upon previous marketing research (Achrol, Reve and Stern, 1983; Stern and Reve, 1980) and their review of the logistics literature that specifically addresses external marketing factors (Barry, Girard and Perras, 1993; Bronstad and Evans-Correia, 1992; Cairncross, 1992; Kopicki, Berg, Legg, Dasappa and Maggioni, 1993; Livingstone and Sparks, 1994; Murphy, Poist and Braunschweig, 1995; Pohlen and Farris II, 1992; Stock, 1992), Carter and Ellram (1998) developed a framework which describes the forces that affect RL disposition activities. Their framework posits that the task environment consists of four distinct organizational entities that affect the firm’s disposition decision. They are: 1. suppliers (input), 2. buyers (output), 3. government (regulatory), and 4. competitors (competitive).

The task environment is encompassed within the overall market environment consisting of legal, economic, political, and social variables. All of these factors must be measured when a decision maker considers a disposition alternative. Figure 1 is the framework proposed by Carter and Ellram (1998), as adapted from Achrol, Reve and Stern (1983). The model depicts their reverse logistics disposition options in the center of the diagram and demonstrates the variety of factors that affect the disposition decision.

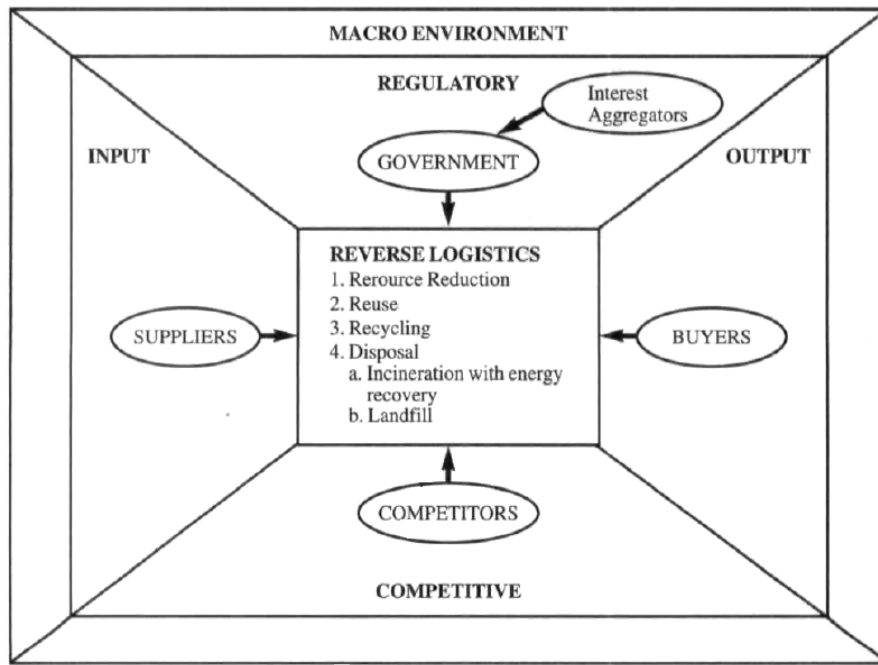


Figure 1: Carter and Ellram's model of the environmental forces affecting reverse logistics activities (1998, p. 94)

Carter and Ellram's (1998) conceptual model is the first comprehensive reverse logistics decision framework. It takes into account factors that are beyond the normal scope of logisticians and illustrates the importance of holistic decision making. Their work provided the foundation for further investigation, as demonstrated by Knemeyer, Ponzurick, and Logar (2002) when they updated the model to account for factors recognized in more current research. Taking into account the theory-building work of Dowlatshahi (2000) and a review of the contemporary literature at the time, Knemeyer, et al.'s (2002) model accounts for both operational and strategic concerns. This research demonstrates that a firm must consider both operational and strategic implications in regard to their RL processes, which is congruent with the findings of Rogers, Lambert, Croxton and Garcia-Dastague (2002). Additionally, Knemeyer et al. (2002) outline the operational and strategic factors that can affect the general RL process. This framework clearly shows the complexity of the decision environment and the breadth of knowledge that must be available to make an informed decision.

Tan and Kumar's (2006) reverse logistics decision making model provides a resource for decision makers looking to choose the most profitable disposition activity. The authors validated their model and the findings of a previous study (Tan, Yu and Kumar, 2003) with a computer industry case study, demonstrating the ability to make an equitable decision for the subject firm in regard to a specific product line. The decision included unit and variable costs: local transportation, handling, acquisition, customs duty, repair, reuse, scrap, storage, and long-distance freight costs. Although it provides a complete account of the costs involved in RL and the activity's ability to maximize profits, their model did not account for strategic considerations, thus encouraging additional research opportunities.

Mollenkopf, Russo, and Frankel's (2007) investigation into the returns management process revealed the strategic and cross-functional nature of RL. They interviewed 16 managers serving in various functions and capacities across five companies and discovered that adherence to strategic goals and policies and integration across internal business functions is paramount to effective returns management. They also found that returns management is an important link between logistics and marketing. The findings of the qualitative study illustrate the importance of strategy, functional integration, and supply chain orientation in positioning a firm to contend with external factors.

The frameworks discussed above (Carter and Ellram, 1998; Knemeyer et al., 2002; Mollenkopf et al., 2007; Tan and Kumar, 2006) describe the holistic nature of the disposition decision. Most importantly, all but one (Tan and Kumar, 2006) recognize the strategic consequences of the disposition decision. In this vein, Croxton et al. (2001) describe the returns management processes as one of the eight supply chain business practices represented in the supply chain management model originally developed by Cooper et al. (1997) and later modified by Lambert, Cooper, and Paugh (1998). Croxton et al. identify the strategic considerations regarding the returns management process. Their framework identifies the strategic processes within returns management and how these processes and subsequent activities interact with the other supply chain processes and operational returns processes as identified by the Lambert model. Rogers et al. (2002) expanded upon this framework, suggesting that the key to managing returns is found in aligning RL goals and policies with overall firm strategy with the

ultimate goal of increasing profits. Although this framework highlights the strategic steps that a firm must take to implement returns processes, it does not define strategic decision-making factors in regard to whether or not a firm should adopt reverse logistics practices in the first place.

Skinner, Bryant, and Richey's (2008) qualitative examination of disposition options further validates the need for disposition decisions to be based upon a firm's overall strategy in lieu of trying to maximize profits on a case by case basis. By interviewing and surveying the top supply chain professional from a variety of companies in the auto parts industry, Skinner, et al. (2008) suggested that cross-functional integration and a strategic focus were critical to the continued success of the returns management process. Through use of strategic and holistic decision making practices, a firm can select their most profitable disposition alternative given its core competencies and strategic focus. Their research suggests that the return policy adopted by a firm provides an opportunity for competitive advantage. Therefore, a firm should work to align this policy (and subsequently its choice of disposition alternative) with its overall strategy. The disposition alternatives are matched with the level of resource commitment to determine how strategic performance (economic, responsiveness, or service) may be enhanced. The authors conclude that indeed organizational strategy should drive the choice of disposition alternative.

Jayaraman and Yadong (2007) propose that RL is strategic in nature and can directly impact the bottom line. However, they acknowledged that both financial and non-financial considerations drive a firm's use of RL. Not only must a firm look to maximize profits, but it must take into account competitive pressures, environmental regulation, and corporate citizenship. Further, Jayaraman and Yadong (2007) recognized the system-level effects of a firm's RL policies. Their framework describes the interdisciplinary nature of the RL disposition decision and demonstrates how a firm may derive value from its returned products and promotes the idea that all of a firm's activities should seek to increase profits.

Although research suggests a strategic focus within the RL disposition decision, other frameworks continue to emphasize the environmental and legislative concerns that often contribute to the decision making process. For example, De Brito and Dekker's (2002) model emphasizes corporate citizenship, legislation, and economics as the driving forces behind RL practices. Furthermore, Rogers and Tibben-Lembke (2001) highlight the overlapping considerations between green logistics and RL, suggesting the impact that green principles may have on RL decision making. Specifically, they describe the activities of recycling, remanufacturing and use of reusable packing as overlapping between green logistics and reverse logistics. In short, RL strategy and decision making differentiates itself from other corporate functions in that a variety of additional factors (i.e., environmental, corporate citizenship, etc.) must be considered in addition to profit maximization (e.g. Ravi, Shankar and Tiwari, 2005; Wadhwa, Madaan and Chan, 2009).

FINDINGS

Engaging in a review such as this enables researchers to begin to understand the complexities of knowledge needs surrounding a particular decision context. Knowledge management frameworks begin with the idea that information should be acquired by whatever means to begin the process of transforming information into action (Alavi and Leidner, 1999, 2001; Davenport and Prusak, 1997). This review acquired information that indicates that there are seven factors affecting the disposition decision. These factors were assimilated into the following categories: supply chain and manufacturing considerations, costs associated with RL, market considerations, customers, profits associated with RL, environmental concerns, and regulatory concerns. Table 3, below, presents an aggregated content analysis of the RL framework literature.

Author(s)	Customers	Natural Environment	Market Conditions	Supply Chain Capabilities	Regulation	Profit from RL	Cost of RL
Carter & Ellram (1998)	✓	✓	✓		✓		
Croxton et al. (2001)	✓	✓	✓	✓	✓		
Dowlatshahi (2005)	✓	✓			✓		✓
Jayaraman & Yadong (2007)	✓	✓	✓		✓	✓	
Knemeyer et al. (2002)	✓	✓	✓		✓	✓	✓
Mollenkopf et al. (2007)	✓		✓	✓	✓		
Ravi et al. (2005)	✓	✓	✓		✓	✓	✓
Rogers et al. (2002)	✓		✓	✓		✓	
Skinner et al. (2008)	✓					✓	
Staikos & Rahimifard (2007)	✓	✓	✓	✓	✓	✓	✓
Tan & Kumar (2006)	✓			✓		✓	✓
Tan et al. (2003)	✓			✓			✓
Wadhwa et al. (2009)	✓	✓	✓		✓		✓

Table 3: Content analysis of strategic frameworks

Once the complexities of the decision are better understood, the information must be usable. Certainly, there are practical implications. For example, while both cost of and potential profit from changing RL processes are important information to the organization, the effect of the customers’ satisfaction cannot be underestimated. A knowledge system designed to facilitate the RL disposition decision must begin with knowledge base of not only customer behavior, but of customer ideals and requirements also. Because RL processes are often environmentally sensitive, customers may be willing to pay more to ensure responsible disposition. Conversely, organizations may need to absorb the cost of mandated disposition processes when customers are unwilling or unable to absorb a price increase. Clearly, the depth of knowledge necessary for each of the seven factors requires a system that is able to not only acquire information, but maintain and analyze data at multiple levels. As with most knowledge, although these factors appear to be applicable across industries, the level and depth of information is likely to differ across not only industries, but also among organizations within an industry.

PROPOSITIONS FOR FURTHER RESEARCH

This research has developed a set of constructs for which information must be gathered to support an organization’s reverse logistic process improvement. From a research standpoint, it extends our understanding of the breadth of the knowledge necessary to support the decision process regarding disposition. Still, much work remains to be done.

Further research is required in order to determine the relevance and subsequent weight of the factors identified in this review. To this end, the authors offer the following propositions.

- *Proposition 1: The potential cost of RL affects a firm’s decision as to which RL disposition alternative to adopt.*
- *Proposition 2: The potential profit from RL affects a firm’s decision as to which RL disposition alternative to adopt.*
- *Proposition 3: Market conditions affect a firm’s decision as to which RL disposition alternative to adopt.*

- Proposition 4: Customer behavior affects a firm's decision as to which RL disposition alternative to adopt.
- Proposition 5: A firm's existing supply chain and manufacturing capabilities affect a firm's decision as to which RL disposition alternative to adopt.
- Proposition 6: Regulatory factors affect a firm's decision as to which RL disposition alternative to adopt.
- Proposition 7: The environmental effects of RL affect a firm's decision as to which RL disposition alternative to adopt.

Each factor discovered in this literature review requires further investigation to examine its potential influence on RL disposition decision. Although a generic model may not be possible given the strategic and subjective nature of the RL disposition decision, generalizations can be made through future research efforts. First, case study or further meta-analysis can be used to determine the relevance of the seven factors identified. Next, Delphi methods or survey-based research can be employed to determine the relative impact of each of these factors. Regardless of the methodology employed, quantifying not only the relevance but the weight of these factors is important to understanding the RL disposition decision and subsequently building a knowledge and decision support system to enhance an organization's ability to improve RL processes.

CONCLUSION

A review of existing RL framework literature was performed and a content analysis was conducted. The factors identified by this review are posited to be relevant to the RL disposition decision process. However, determining the significance of each will be a challenging research endeavor as the author suspects that each firm and each situation may vary considerably in their approach to RL. Furthermore, investigating the relationship between factors will require a broad yet cohesive future research effort. Akin to Carter and Ellram's (1998) research, this article provides a starting point to aid future research and investigate causal relationships. Future research is suggested to test the propositions presented in order to gain further understanding of the factors affecting the RL disposition decision. Ultimately, creation of a knowledge management and decision system is possible once the complexities of these factors are understood. Such a system will aid practitioners in making the most advantageous decisions in regard to managing their RL processes. Finally, this effort has helped to bridge the gap in the Lambert model between the RL process and a firm's strategy by identifying the factors that require strategic consideration.

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