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ABSTRACT

Business to business reverse logistics processes are shaped in large part by a firm's strategy to meet regulatory (e.g. waste electrical and electronic equipment directive) and certification (e.g. ISO 14000) requirements. Firms adopt both recommended and internally developed reverse logistics metrics in order to monitor the performance of these processes along the entire value chain, and especially amongst both buyer and supplier marketing interactions. Unfortunately, literature regarding antecedents to and outcomes of reverse logistics metric development is scarce, leaving industrial marketing professionals with limited guidance as to how to establish and gain value from a sophisticated metric program. This study uses goal-setting theory and the knowledge-based view to conceptualize a model that examines transactions from the perspective of both the supplier (inbound reverse logistics) and customer (outbound reverse logistics) in a business to business context. This granular view reveals how actors occupying different supply chain positions manage collaborative marketing processes such as reverse logistics. Survey data were gathered from organizations affiliated with the United States Department of Defense supply chain and hypotheses were tested using partial least squares structural equation modeling. The results corroborate the assertion that information support capabilities and stated goals are antecedents to establishing metrics; however, the study uncovers outcome disparities between inbound and outbound reverse logistics processes. As the roles of both suppliers and customers in complying with take-back regulation continue to grow, the findings of this study provide marketing professionals and scholars with important insights regarding the use of reverse logistics metrics.

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1. Introduction

Firms rely on effective and consistent supply chain management processes, systems, and metrics in order to keep costs down and remain competitive (Closs, 1989; Mondragon, Lalwani, & Mondragon, 2011). Lambert and Pohlen (2001) identify factors that underlie the need for metrics specific to supply chain applications and a variety of other studies have identified and discussed such metrics (Gunasekaran & Kobu, 2007; Gunasekaran, Patel, & Tirtiroglu, 2001; Kleijnen & Smits, 2003). Although several reverse logistics metrics have been proposed in the literature (Stock & Mulki, 2009), investigation of the antecedents to the establishment of these metrics and the outcomes realized via instituting such metrics has not been well examined in the marketing and supply chain management literature and is almost entirely absent in the reverse logistics literature. Given the proliferation of take-back regulation, an emphasis on sustainable marketing and logistics practices, and business' endless desire to enhance efficiencies, the need for firms to use reverse logistics-specific metrics is increasing. In this study, we investigate antecedents to the establishment of reverse logistics metrics as well as whether or not these metrics can ultimately help to reduce reverse logistics costs.

In this paper, reverse logistics is defined as "…the movement of goods from a consumer towards a producer in a channel of distribution" (Pohlen & Farris, 1992, p. 36). Notably, this paper investigates reverse logistics from the business-to-business marketing perspective. In this arena, it is critical for marketing managers to liaise with their logistics counterparts to ensure effective processes and customer satisfaction. In this regard, reverse logistics activities affect several functions across an enterprise, to include logistics, marketing, operations, and others. Appropriate metrics can help to shape communication and coordination across functions. For instance, reverse logistics metrics might help to enable the production function's support of marketing initiatives, or help to inform marketing professionals with regard to supplier selection and retention.

In a business-to-business environment, reverse logistics processes are often encompassed within a closed-loop system (Sarkis, 2012). That is, products first flow outbound to a customer (forward logistics); those same products then flow back inbound, often in an altered state

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or condition (reverse logistics) (Jayaraman & Guide, 1999). Therefore, examination of the reverse logistics process may be complicated by the fact that each organization within the closed-loop system serves two functions; organizations that are "senders" in the forward logistics process become "receivers" in the reverse logistics process, and vice versa. Because of the inherent differences between inbound and outbound logistics processes (Stock & Lambert, 2001; Svensson, 2002a, 2002b), it follows that the antecedents to and outcomes of metrics may be dependent upon the organization's function within the return transaction.

Most of the reverse logistics research considers only the perspective of the organization that is receiving returns from its customers. Although investigating this perspective is important to helping firms understand how to manage their own returns and associated processes, it must be noted that, as with most processes within the supply chain, multiple stakeholders are involved in reverse logistics processes (Olorunniwo & Li, 2010). Due in part to growing regulatory and societal pressures to adopt environmentally sustainable practices, the need to examine both the supplier's *and* the customer's role in reverse logistics is becoming increasingly important. Although of little consequence prior to the 1960s (Murphy, Poist, & Braunschweig, 1995), environmental concerns have evoked a variety of regulations in recent years that significantly affect marketing and logistics processes (McKinnon, 2012; Murphy et al., 1995). For instance, the United Kingdom's Environment Agency Landfill Directive "pre-treatment" requirement dictates that producers of waste take steps to reduce the amount and impact of non-hazardous waste, often requiring material to be returned to the supplier or other entity for disposition, and the European Community's waste electrical and electronic equipment (WEEE) directive requires collection, recycling, and take-back of electronic equipment that necessitates additional transactions after the initial sale to ensure proper disposition (Cherrett, Maynard, McLeod, & Hickford, 2012). The United States is also taking steps to adopt similar regulation. Although there is currently no federal-level legislation similar to WEEE, we found that 25 states have passed legislation requiring electronic waste recycling to some degree. While many of these laws assign responsibilities to suppliers, the customer is still required to participate and, in some states, the onus is entirely upon the customer to comply. The aforementioned regulation is reshaping marketing relationships between suppliers and customers and necessitates more in-depth examination of expanding responsibilities of both parties.

Considering the preceding discussion, this study considers the antecedents to and outcomes of a reverse logistics metrics from two perspectives. We examine metrics from the perspective of the organization that is receiving the returned product. We term this perspective "inbound." We also examine metrics from the perspective of the organization that must return the product and wait for a replacement or credit. We term this perspective "outbound." Although we separate the reverse logistics process into inbound and outbound components, it should be recognized that most organizations within a supply chain will inevitably assume both functions. However, our point is that additional insight may be gained by decomposing the reverse logistics process into these two functions in order to provide a more focused investigation of each function and glean more actionable information for marketing and logistics managers.

Our investigation into reverse logistics metrics is motivated by the following questions: What are the antecedents to establishing metrics for reverse logistics? Does establishing reverse logistics metrics enhance reverse logistics effectiveness? Do the antecedents to or outcomes of metrics differ between inbound and outbound functions? We explore these questions from the perspective of goal-setting theory in combination with the knowledge-based view (KBV) of the firm. In the next section, we use the aforementioned theories as the foundation to build our conceptual model. Then, we go into greater detail to develop the specific relationships presented in our model, which culminates in the presentation of our hypotheses. Next, we describe our survey data collection and partial least squares (PLS) structural equation modeling analysis. We then report our findings and discuss implications for research and practice. This article closes with a short discussion of limitations and additional research opportunities.

2. Conceptual development and hypotheses

Considering previous work regarding conscious goals and the effect of such goals on task performance (Lewin, Dembo, Festinger, & Sears, 1944; Mace, 1935), goal-setting theory is based on Ryan's (1970) assertion that conscious goals affect action. Goal-setting entails the process of establishing levels of performance in order to motivate desired outcomes (Locke & Latham, 2002; Locke & Latham, 2006). The theory has been operationalized at many levels of analysis, to include the individual, group, and organizational levels (Locke & Latham, 2005).

Extant literature has examined several goal-setting conditions. Based on previous literature regarding performance measurement in the supply chain (Griffis, Cooper, Goldsby, & Closs, 2004; Griffis, Goldsby, Cooper, & Closs, 2007), we examine how the conditions of goal specificity (Locke & Latham, 2006) and feedback (Sorrentino, 2006) influence the establishment of metrics. Specifically, we assess stated organizational goals for reverse logistics as a proxy for specificity and information support capabilities as a means by which to acquire feedback. In the context of goal-setting theory, we focus our attention on the establishment of metrics as a surrogate for the operationalization of organizational goals for reverse logistics (Blanchard, Zigarmi, & Zigarmi, 1985; Doran, 1981). Goal-setting has been shown to be both directly and indirectly related to several practical outcomes (Latham & Baldes, 1975), such as measures of productivity (Latham & Locke, 1975), performance (Latham & Kinne, 1974; Latham & Yukl, 1975), and profitability (Terpstra & Rozell, 1994). Research in goal-setting theory posits that there are two paths to achieving such outcomes: one path is motivated by goals and the other path is motivated by other factors that are not necessarily associated with goal-setting (Locke, 2000). However, both paths can be associated with task knowledge (Locke, 2000). In this way, metrics might represent a knowledge-based resource that can be used to complement goal-setting theory and explain how an organization might bridge the gap between goals and performance.

The resource-based view (RBV) of the firm suggests that organizations use rare, valuable, and inimitable resources to create competitive advantage (Barney, 1991; Dierickx & Cool, 1989; Mahoney & Pandian, 1992; Penrose, 1959; Priem & Butler, 2001). The KBV of the firm is an extension of RBV and considers knowledge as a strategically significant resource that can indeed be rare, valuable, and inimitable (Conner, 1991; Grant, 1996; Kogut & Zander, 1992; Spender, 1996); such knowledge may be entrenched within an organization's policies, procedures, systems, and routines. Like goals, knowledge can be thought of as having the potential for influencing action (Carlsson, 2003). Considering knowledge as a capability, knowledge can be seen as the capacity to ascertain and communicate what information is necessary for decision making (Watson, 1999). In order for an individual's, group's, or organization's knowledge to be useful, it must be expressed in a way that is interpretable to others (Alavi & Leidner, 2001). In an attempt to manage and capitalize upon its knowledge, organizations must build an infrastructure consisting of not just a technical (e.g. information) system, but also of networks of people and processes (Davenport & Prusak, 1998).

Literature on the KBV suggests that organizations consist of four knowledge processes: creation, storage/retrieval, transfer, and application (Alavi & Leidner, 2001; Holzner & Marx, 1979; Pentland, 1995). From this perspective, it follows that managerial metrics might provide a mechanism to support both transfer and application processes. In regard to transfer, the establishment of a metric can be seen as a formal knowledge transmission channel that explicitly informs members of organizational values and goals. A technology-enabled knowledge system

(in this study, metrics) transmits norms, beliefs, and expectations from upper management to organizational members (Bloodgood & Salisbury, 2001).

More important than transfer processes are the application knowledge processes because it is in the actual application of knowledge where firms can achieve performance outcomes (Alavi & Leidner, 2001). Knowledge can be integrated to create organizational capabilities via organizational routines, which can refer to the development of task performance patterns that allow individuals to apply knowledge (Grant, 1996). Thus, systems designed to support the management and exploitation of organizational knowledge must compliment the firm's activities. This study examines the path from goals, to metrics, to performance in the context of reverse logistics. The metric construct is positioned at the center of the model and is hypothesized to be the knowledge mechanism that translates goals to performance. Also included are the processing capabilities (information systems and processing effectiveness) that play a secondary, supporting role to enable metrics and cost effectiveness.

Our hypothesized model, illustrated as Fig. 1, addresses the aforementioned relationships and is positioned orthogonally within the domain of both goal-setting theory and KBV. In the remainder of this section, we develop the relationships described within this model in greater detail and state our specific hypotheses.

2.1. Antecedents to metrics

A metric is defined as a measure of product or process performance (Hahn, Austing, & Strickmann, 2008). Metrics are used to determine the feasibility of strategies "without which a clear direction for improvement and realization of goals would be highly difficult" (Gunasekaran et al., 2001, p. 72). In this research effort, we examine two antecedents to establishing such metrics to manage reverse logistics processes. In this section, we describe why goals and information system capabilities may be necessary conditions for instituting metrics.

Information system capabilities are derived from the integration of information technology, knowledgeable staff, and processes and have the potential to provide a firm with a competitive advantage (Bhatt & Grover, 2005). In the context of reverse logistics, we define information systems capabilities as the ability to send and receive information within and between organizations (Daugherty, Ellinger, & Rogers, 1995; Daugherty, Myers, & Richey, 2002). Because return flows are often characterized by high variability, research suggests that information system capabilities are especially important for managing reverse logistics processes (Daugherty et al., 2002; Evangelista, Mogre, Perego, Raspagliesi, & Sweeney, 2012; Li & Olorunniwo, 2008). Unfortunately, early research by Rogers and Tibben-Lembke (2001) found that few firms had information systems that could handle the return process and that many firms did not see developing that capability as a priority. In fact, over one-third of the 311 logistics managers who responded to their survey identified the lack of reverse logistics information systems as a serious impediment to effective reverse logistics processes (Rogers & Tibben-Lembke, 2001). However, as information technologies have greatly proliferated in the years since their study, more organizations are likely embracing information systems in support of reverse logistics operations (Cheng & Lee, 2010). For instance, scholars have now even proposed such ideas as a Reverse Enterprise System that is capable of serving both forward and reverse flows of information and products, which incorporates decision and information systems across system boundaries (Madaan, Kumar, & Chan, 2012). It follows that firms with greater information system capabilities will be in a better position to measure reverse logistics processes. In the context of goal-setting theory, information system capabilities provide the requisite feedback mechanism to assess metrics. From the KBV perspective, information systems can positively influence knowledge transfer and application (Alavi & Leidner, 2001), which we posit is achieved via the establishment of metrics. Therefore, we offer the following hypotheses.

H1a. Information system capability for reverse logistics is positively related to the number of metrics established to manage inbound reverse logistics.

H1b. Information system capability for reverse logistics is positively related to the number of metrics established to manage outbound reverse logistics.

The goals of a firm determine the distinctiveness of its operations and dictate the number and types of metrics that the firm should establish (Griffis et al., 2004). Goals provide a target for success, which facilitates the strategic distribution of resources in an effort to reach that

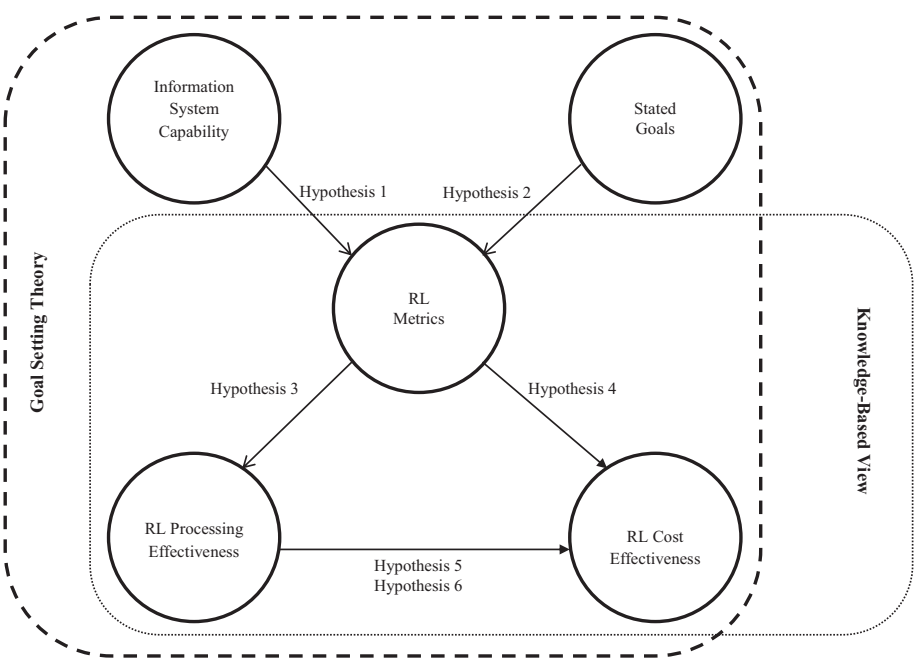


Fig. 1. Hypothesized model.

goal. According to goal-setting theory, goals establish a level of performance and motivate desired outcomes (Locke & Latham, 2002; Locke & Latham, 2006). Metrics are (or at least, should be) derived from these organizational goals (Shahin & Mahbod, 2007). Atlee and Kirchain (2006) suggest that useful, robust, and feasible metrics are essential to measuring the progress toward and achievement of goals. Therefore, we propose that there is a positive relationship between the number of organizational goals for reverse logistics and the number of metrics that the organization has established for reverse logistics.

H2a. The number of organizational goals for reverse logistics is positively related to the number of metrics established to manage inbound reverse logistics.

H2b. The number of organizational goals for reverse logistics is positively related to the number of metrics established to manage outbound reverse logistics.

2.2. Metrics and performance outcomes

Ravi and Shankar (2005) found that the lack of established performance measures was one of the major barriers to a successful reverse logistics processes. Bernon, Rossi, and Cullen (2011) propose that although management reporting and control of reverse logistics processes are not well developed in either theory or practice, using appropriate performance measures can drive desired behaviors within the firm. Indeed, metrics provide the positive feedback that motivates behavior as described by goal-setting theory (Locke & Latham, 2002; Locke & Latham, 2006). Thus, it follows that reverse logistics metrics, as a means of transferring and applying knowledge, will drive operational performance. In the context of reverse logistics, one of the most relevant measures of operational performance is processing effectiveness, which entails how quickly and easily a return transaction can be processed by a firm (Richey, Genchev, & Daugherty, 2005). Therefore, we offer the following hypotheses.

H3a. The number of metrics established to manage reverse logistics processes is positively related to inbound reverse logistics processing effectiveness.

H3b. The number of metrics established to manage reverse logistics processes is positively related to outbound reverse logistics processing effectiveness.

There are many outcomes of reverse logistics processes that are commonly assessed in the literature, such as customer satisfaction, operational effectiveness, and cost effectiveness (Daugherty, Autry, & Ellinger, 2001; Daugherty et al., 2002; Richey, Daugherty, Genchev, & Autry, 2004; Richey, Genchev, & Daugherty, 2005). Because of the recognized need to closely link logistics performance with firm performance (Fugate, Mentzer, & Stank, 2010), we propose that cost effectiveness may be among the most salient of outcomes to consider. We define reverse logistics cost effectiveness as the degree to which an organization's reverse logistics processes and programs reduce organizational costs (Christmann, 2000; Richey, Chen, Genchev, & Daugherty, 2005). Whereas processing effectiveness is comprised of non-financial measures of how well the firm satisfies the demands of trading partners and cost effectiveness includes measures of how economically the organization utilizes its resources in meeting those demands (Bhagwat & Sharma, 2007; Neely, Gregory, & Platts, 2005).

Controlling costs is a key goal for reverse logistics processes (Richey, Chen, Genchev, & Daugherty, 2005). Total annual logistics costs can be reduced by as much as 10% when firms efficiently manage their reverse logistics processes (Minahan, 1998). Therefore, formalized reverse logistics processes may represent a rare, valuable, and not easily imitable knowledge resource that can be used to attain a marketplace advantage by way of enabling more cost effective processes. Formalization refers to the extent to which procedures and instructions are routinized to govern a firm's reverse logistics processes (Pugh, Hickson, Hinings, & Turner, 1968; Richey, Chen, Genchev, & Daugherty, 2005). Scholars measure process formalization via examining the degree to which written procedures, policies, and program evaluation measures are in place (Richey, Chen, Genchev, & Daugherty, 2005; Song & Perry, 1993). Consequently, we consider the establishment of metrics as a means by which organizations can routinize and formalize their reverse logistics processes. It follows that firms with a more formalized process as indicated by the establishment of specific reverse logistics metrics will achieve higher levels of reverse logistics cost effectiveness than firms that do not possess such a resource (Bernon et al., 2011). Thus, we posit the following hypotheses.

H4a. The number of metrics established to manage reverse logistics processes is positively related to inbound reverse logistics cost effectiveness.

H4b. The number of metrics established to manage reverse logistics processes is positively related to outbound reverse logistics cost effectiveness.

We examine two performance outcomes: processing effectiveness, which is primarily operational, and cost effectiveness, which is primarily financial. However, several studies suggest that there is often a strong, positive relationship between measures of operational performance and measures of financial performance (Britto, Corsi, & Grimm, 2010; Capkun, Hameri, & Weiss, 2009; Inman, Sale, Green, & Whitten, 2011). Additionally, operational performance is often found to be an important preceding factor to financial performance (e.g., Inman et al., 2011; Wouters, Kokke, Theeuwes, & Van Donselaar, 1999; Wu & Chuang, 2010). Indeed, in addition to having a direct relationship with financial performance, operational capabilities are often shown to help provide the linkage between resources and financial outcomes (Tallon & Pinsonneault, 2011; Vickery, Droge, Setia, & Sambamurthy, 2010). Thus, in addition to a direct hypothesis between processing effectiveness and cost effectiveness, we also examine the role of processing effectiveness in the relationship between metrics and cost effectiveness.

H5a. Reverse logistics processing effectiveness is positively related to inbound reverse logistics cost effectiveness.

H5b. Reverse logistics processing effectiveness is positively related to outbound reverse logistics cost effectiveness.

H6a. Reverse logistics processing effectiveness mediates the relationship between number of metrics established to manage reverse logistics and inbound reverse logistics cost effectiveness.

H6b. Reverse logistics processing effectiveness mediates the relationship between number of metrics established to manage reverse logistics and outbound reverse logistics cost effectiveness.

3. Data collection

We employed a survey method as a means of data collection. In this section, we describe our data collection procedures.

3.1. Participants

This study required a sample frame comprised of business-to-business trading partners. As a suitable sample frame, we chose organizations that are affiliated with the United States Department of Defense supply chain. The defense industrial base is comprised of tens of thousands of contractors and subcontractors that provide goods and services to the DoD (House Committee on Armed Services, 2012). However, several of the organizations in this sample do business outside of the

Table 1
Individual and organizational demographics.

Experience	
Mean years in current position	6.21
Mean years in organization	11.28
Mean years reverse logistics experience	7.75
Position	
Senior management	30%
Middle management	40%
Log. professional	21%
Other	9%
Gender	
Female	22%
Male	78%
Organization size (count of employees)	
Mean organization size	11,588
Mean organization unit size	89
Scope of operations	
Regional	8%
National	45%
International	47%
Industry	
Technology	41%
Aerospace	22%
Medical	14%
Heavy equipment/automotive	18%
Other	5%

Notes: Combined n = 136; 60 inbound; 76 outbound.

government as well; indeed, as shown in the summary of participant demographics (Table 1), 47% of participants work for an organization that conducts business internationally. Therefore, this particular sample allows for homogeneity, yet also provides some degree of generalizability. Nonetheless, we realize that there are some limitations to this sample frame, which will be discussed later in this paper. For instance, as the data in Table 1 suggest, participants work in organizations of larger size, and a relatively limited number of industries are represented.

We obtained a listing of contacts from within private, public, and government organizations from a variety of industries that do business in support of the Department of Defense. We solicited participants who were identified to us as working within or overseeing reverse logistics processes. To participate, respondents must have had managerial responsibilities over a reverse logistics process, worked within the process as a logistics professional, or otherwise played a significant role in the process. As shown in Table 1, participants averaged 7.75 years of experience with managing reverse logistics processes. Via e-mail, participants were provided a link to an Internet-based questionnaire and an information letter that described our research. By accessing the questionnaire, participants acknowledged consent.

Upon accessing the questionnaire welcome page, participants were asked to identify whether the process that they are familiar with (and would be the focus of their responses) is concerned with shipping returned products back to their suppliers or receiving returned products from their customers. The response to this initial question directed participants to either the inbound or outbound questionnaire. Although we used the same measures for both inbound and outbound, we tailored the questionnaire instructions for appropriate context based on the participant's reverse logistics perspective. We sent e-mails to 450 potential participants. We received 60 complete responses for inbound and 76 complete responses for outbound for an effective response rate of 30.2%.

3.2. Measures

We relied upon existing measures to develop our survey instrument. In order to measure reverse logistics cost effectiveness, we used items initially employed by Richey, Genchev, and Daugherty (2005) and also employed by Jack, Powers, and Skinner (2010). Reverse logistics processing effectiveness was measured using items from Richey, Genchev, and Daugherty (2005), which were based on the work of Autry, Daugherty, and Richey (2001). Information system capability was assessed using a measure employed by Daugherty et al. (2002). We considered each of the measures to be reflective and all items were assessed using a 7-point Likert scale. Only minor modifications were made to the original items for context; our measures can be found in Appendix A. To assess goals and metrics, we asked participants to provide a count of reverse logistics goals that are clearly stated within the organization (via directive, policy, goal-statement, etc.) and the count of metrics that are actively employed to assess reverse logistics processes. This measurement approach is based on the assumption that a greater number of goals and metrics will indicate a greater degree to which the firm is committed to them. Table 2 reports statistics regarding the performance of our measures.

4. Analysis and results

Prior to data analysis, we examined the data for adherence to statistical assumptions and the manifestation of potential biases. The data adhered to the assumptions of normality, independence, homogeneity, and linearity (Kutner, Nachtsheim, Neter, & Li, 2005). We assessed non-response bias using wave analysis, which compared early responders to late responders (Rogelberg & Stanton, 2007; Wagner & Kemmerling, 2010). Examination of item values and demographics indicated no significant differences in responses.

Common method bias was addressed in accordance with methods prescribed by Podsakoff, MacKenzie, Lee, and Podsakoff (2003). To begin, we sought to allay bias via the study design. In as much, we protected anonymity, provided clear directions, proximally separated independent and dependent variables, refrained from using reverse-scored or negatively-worded items, and assured participants that it is acceptable to leave an item blank if they do not feel comfortable responding (Harrison & McLaughlin, 1991; Podsakoff et al., 2003; Schmitt, 1994; Schmitt & Stults, 1985). We also carefully pilot tested the survey instrument to increase the clarity and readability of items, reduce item complexity, and reduce the use of jargon (Hinkin, 1995, 1998, 2005; Peterson, 2000; Spector, 1987, 1992).

Although the aforementioned actions help to reduce potential bias, we conducted several tests to statistically examine the data for indications of common method bias. First, Table 2 shows the correlations between factors in this study; the highest correlation is r = .59, which is below the suggested maximum threshold of r = .90 (Podsakoff et al., 2003). Second, we employed Harman's one factor test (Brewer, Campbell, & Crano, 1970; Greene & Organ, 1973; Harman, 1960; Podsakoff & Organ, 1986), which showed that no one factor accounted for greater than 50% of the variance. Additionally, Table 3 shows the factor analysis results, which indicates that variance is distributed among each of the factors in this study, rather than being concentrated on one factor. Finally, following the procedure described by Liang, Saraf, Hu, and Xue (2007, pp. 85–87), we assessed method variance by including a latent method factor in our PLS model, where all indicators load on both their substantive construct and the method factor (Podsakoff et al., 2003). We compared the variances and t-values of each indicator explained by the method factor and the substantive construct. For each indicator, we found that method factor loadings were either insignificant, or that the variance attributed to the method factor was considerably less than the variance attributed to the substantive construct. These findings indicate that common method bias is not a significant threat to the validity of our findings (Williams, Edwards, & Vandenberg, 2003).

We used SmartPLS 2.0M3 (Ringle, Wende, & Will, 2005) structural equation modeling as a means for data analysis and hypothesis testing. We chose PLS because of its usefulness in analyzing structural models with both multiple-item and single-item constructs and testing for mediation (Ahuja, Galletta, & Carley, 2003; Chin & Todd, 1995; Gefen,

Table 2
Construct descriptives and correlations.

Construct	Items	Mean	Std. Dev.	C.A.	C.R.	AVE	CE	PE	ISC	Goals
Cost effectiveness (CE)	4	4.73	1.58	.896	.926	.728	**.853**			
Processing effectiveness (PE)	3	4.59	1.47	.838	.894	.740	.474	**.860**		
IS capability (ISC)	4	4.68	1.52	.867	.898	.689	.590	.493	**.830**	
Goals	1	1.63	1.56	–	–	–	.176	-.058	.021	–
Metrics	1	1.56	1.78	–	–	–	.270	.173	.245	.400

Notes: C.A. = Cronbach's alpha; C.R. = composite reliability; AVE = average variance extracted; square root of AVE is in bold; total n = 136.

Straub, & Boudreau, 2000; Sambamurthy & Chin, 1994). In addition, PLS is preferred over covariance-based structural equation modeling for exploratory research in which theories are integrated or extended, or when a research objective is to explain the variance in the exogenous variable (Gefen, Rigdon, & Straub, 2011; Hair, Sarstedt, Ringle, & Mena, 2012). PLS also requires fewer observations than other modeling techniques (Bock, Zmud, Kim, & Lee, 2005); however, to ensure an adequate sample size, we conducted an a priori power analysis, assuming the need to detect an effect size of .15, with power of .80. Because of the incremental estimation technique used in PLS analysis, only the largest regression in the model must be considered to calculate sample size requirements; thus, we calculated the requirement using the same technique as used for calculating the requirement for regression (Soper, 2012). This calculation indicates a sample size requirement of 53; our samples of 60 and 76 exceed this requirement.

We began our analysis by assessing convergent and discriminant validity. The measurement model was assessed for convergent validity by examining the outer model (Gefen & Straub, 2005). As demonstrated in Table 3, each of the measurement items load appropriately on their intended construct. Convergent validity is also indicated by the composite reliability score. As shown in Table 2, all composite reliability scores exceed the suggested minimum value of .70 (Chin & Newsted, 1999). Convergent validity is also indicated when the average variance extracted (AVE) value for each construct exceeds the minimum threshold of .50 (Fornell & Larcker, 1981). As shown in Table 2, all AVE values are well above .60. In summary, our analysis suggests convergent validity of our measures.

Next, we examined discriminant validity using methods proposed in the literature (Fornell & Larcker, 1981; Gefen & Straub, 2005). When the square root of the AVE of one construct is larger than its correlations with the other constructs or when the square of the correlation is less than the AVE, then discriminant validity is evident. Discriminant validity is thus shown in Table 2 where the square roots of the AVE scores are in bold; the correlations between constructs are shown to be less than the corresponding square root of the AVE. In addition, the square of the correlations are all less than the AVE. Discriminant validity is also evidenced when the items used to measure a construct load higher on their intended construct and lower on all the other constructs (Gefen & Straub, 2005; Straub, Boudreau, & Gefen, 2004). Table 3, which shows the factor analysis results, demonstrates that the item loadings indicate discriminant validity (Cook & Campbell, 1979). In summary, the aforementioned validity checks suggest that our data and model are adequate for hypothesis testing.

Table 3
Factor loadings.

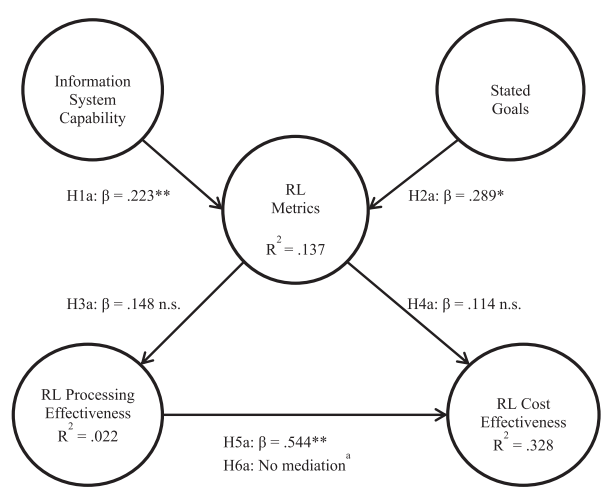
	Cost effectiveness	Processing effectiveness	IS capability	Goals	Metrics
Goals	0.176	−0.058	0.021	**1.000**	0.400
Metrics	0.269	0.173	0.245	0.400	**1.000**
Cost effectiveness 1	**0.720**	0.389	0.463	0.006	0.220
Cost effectiveness 2	**0.918**	0.407	0.531	0.212	0.293
Cost effectiveness 3	**0.853**	0.392	0.506	0.213	0.178
Cost effectiveness 4	**0.905**	0.424	0.506	0.164	0.218
IS capability 1	0.509	0.547	**0.796**	0.004	0.118
IS capability 2	0.463	0.441	**0.883**	0.001	0.181
IS capability 3	0.274	0.281	**0.731**	−0.089	−0.004
IS capability 4	0.549	0.371	**0.899**	0.035	0.274
Processing effectiveness 1	0.468	**0.898**	0.478	−0.025	0.247
Processing effectiveness 2	0.434	**0.914**	0.429	−0.035	0.154
Processing effectiveness 3	0.237	**0.760**	0.323	−0.171	−0.125

Note: Bold indicates highest loading.

4.1. Hypothesis testing

We examined our research model from two perspectives. In the first instance, we modeled the inbound data; in the second instance, we modeled the outbound data. Fig. 2 shows the results of the PLS analysis of our model for inbound reverse logistics. Each path is labeled with its respective hypothesis, path loadings, and t-values. Hypotheses 1a and 5a are significant at the .01 level and Hypothesis 2a is significant at the .05 level. Hypotheses 3a and 4a are not supported. Considering the rules used to establish mediation (Baron & Kenny, 1986; Hair, Black, Babin, & Anderson, 2010), Hypothesis 6a, the mediation hypothesis, is not supported because the direct relationships characterized as Hypotheses 3a and 4a are not significant.

To summarize the results of the inbound model, information system capabilities and number of stated goals for inbound reverse logistics are shown to be significantly related to the number of metrics established to manage inbound reverse logistics. However, the number of metrics established to manage inbound reverse logistics processes has no significant relationship with inbound reverse logistics processing effectiveness or inbound reverse logistics cost effectiveness. Inbound reverse



Notes: [a]Mediation not tenable because of insignificant relationships between RL Metrics and RL Cost Effectiveness, and RL Metrics and RL Processing Effectiveness; n.s. not significant; * significant at p < .05; ** significant at p < .01

Fig. 2. Inbound model results.

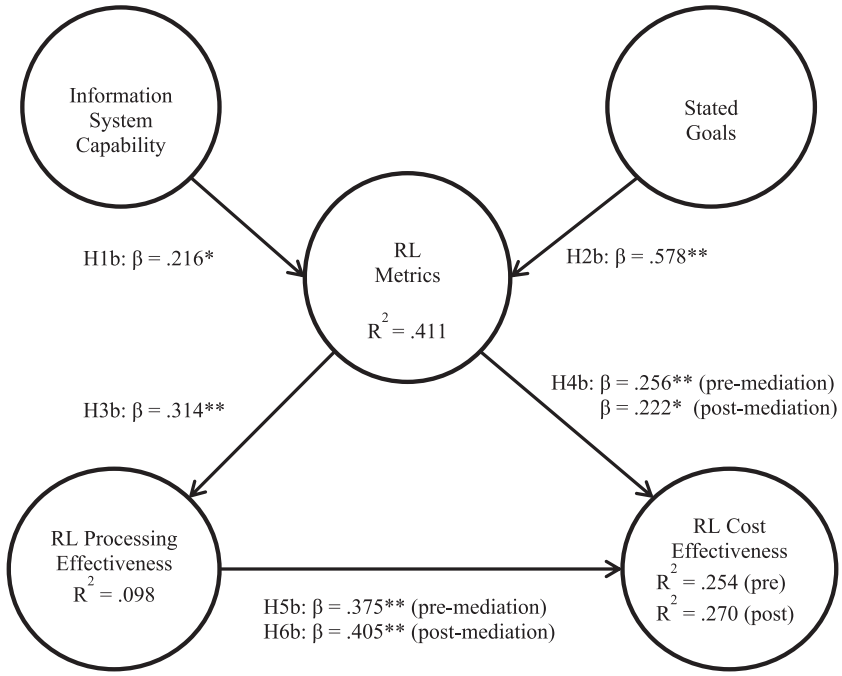


Fig. 3. Outbound model results.

logistics processing effectiveness is shown to be significantly and positively related to inbound reverse logistics cost effectiveness. The model explains 33% of the variance in reverse logistics cost effectiveness ($R^2 = .328$; adjusted $R^2 = .306$).

Fig. 3 shows the results of the PLS analysis of our model for outbound reverse logistics. Each path is labeled with its respective hypothesis, path loadings, and t-values. For outbound reverse logistics, Hypothesis 1b is significant at the .05 level. Hypotheses 2b, 3b, 4b, and 5b are significant at the .01 level. We considered four rules to establish mediation (Baron & Kenny, 1986; Hair et al., 2010) in order to examine Hypothesis 6b. First, the predictor variable must have a significant relationship with the criterion variable (demonstrated by Hypothesis 4b). The second rule is that the mediator variable must also have a significant relationship with the criterion variable (demonstrated by Hypothesis 5b). The third rule is that the coefficient of the path between the predictor and criterion variable must be weaker following mediation (coefficient reduced from .256 to .222 following mediation). The fourth rule of mediation states that the explanatory power of the mediated model must exceed that of the non-mediated model. The R^2 for the mediated model is .270 (adjusted $R^2 = .250$); the R^2 for the non-mediated model is .254 (adjusted $R^2 = .233$). Because all mediation rules are validated, Hypothesis 6b is supported and we conclude that processing effectiveness partially mediates the relationship between metrics and outbound reverse logistics cost effectiveness. To summarize the results of the outbound model, information system capabilities and number of stated goals for outbound reverse logistics are shown to be significantly related to the number of metrics established to manage outbound reverse logistics. Further, the number of metrics established to manage outbound reverse logistics processes is significantly related to both outbound reverse logistics processing effectiveness and outbound reverse logistics cost effectiveness. Outbound reverse logistics processing effectiveness is shown to be significantly and positively related to inbound reverse logistics cost effectiveness, and is also shown to partially mediate the relationship between the number of metrics established to manage outbound reverse logistics and cost effectiveness. In sum, the model explains 27% of the variance in reverse logistics cost effectiveness.

5. Discussion and implications

We examined three research questions: What are the antecedents to establishing metrics for reverse logistics? Does establishing reverse logistics metrics enhance reverse logistics effectiveness? Do the antecedents to or outcomes of metrics differ between inbound and outbound functions? Our exploration and subsequent findings provide insight into several areas that are of interest to marketing professionals and scholars. To begin, our findings reinforce previous research suggesting that clear, specific goals combined with information system capabilities are antecedents to establishing metrics. In addition, this study is one of few to examine actual outcomes of metrics in a supply chain setting. Next, in regard to reverse logistics, this study is one of the first to decompose reverse logistics into separate functions; the findings of this study (i.e., the differences between the inbound model and outbound model) support our notion that there are differences between how the two functions may be managed. Finally, we identified complementarities between goal-setting theory and the KBV to offer a better explanation as to how metrics can help to improve an organization's reverse logistics cost effectiveness. In the remainder of this section, we describe each of the above-mentioned implications.

5.1. Implications for research and theory

Key facets of effective marketing management include controlling costs, satisfying customers, and maximizing efficiencies. Establishing key performance metrics is one way to facilitate such effective management (Croxton, Garcia-Dastugue, Lambert, & Rogers, 2001; Lambert, 2008). Although past research has identified relevant metrics for reverse logistics (Hall, Huscroft, Hazen, & Hanna, 2013; Stock & Mulki, 2009), investigation of antecedents to establishing reverse logistics metrics is scarce in the literature. For both inbound and outbound reverse logistics, our study provides evidence to support the notion that information support capabilities and clear, stated goals are antecedents to establishing metrics. These findings corroborate goal-setting theory conditions and previous research regarding supply chain metrics (Griffis et al., 2004; Locke & Latham, 2006; Sorrentino, 2006). However,

the R^2 for both models suggest that establishing metrics is also a function of additional factors not accounted for in our study. Thus, we suggest that additional factors seen through alternate theoretical lenses might also affect adoption of metrics. Such factors may include performance expectancy, effort expectancy, management support, perceived usefulness, and compatibility (Davis, 1989; Rogers, 2003; Venkatesh & Bala, 2008; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012).

Anecdotally, it is recognized that establishing metrics should foster goal attainment and drive performance; however, there is a dearth of empirical evidence to confirm such assertions. As a way by which to formalize reverse logistics processes, we found evidence to suggest that metrics can facilitate cost effectiveness for outbound reverse logistics, as partially mediated by processing effectiveness. Interestingly, the same is not true for inbound reverse logistics. This finding suggests that metrics may not always drive performance within the supply chain environment. Future research is encouraged to examine where metrics may have the greatest impact on performance, and where they may not be as useful. Operationalizing metrics inherently requires time and resources to implement and sustain; thus, it may be important to determine when such expenditures are warranted.

This study also contributes to the marketing and supply chain literature by further decomposing the supplier-customer relationship in regard to reverse logistics processes. The aforementioned disparity between inbound and outbound reverse logistics processes regarding the links between metrics and processing and cost effectiveness highlights key differences between inbound and outbound reverse logistics functions. As shown in Table 4, the results of our study differed between the two functions. These findings suggest that a formalized reverse logistics process may be more important for the outbound reverse logistics trading partner (the original customer). It follows that reverse logistics competencies may be viewed as being more critical for the outbound reverse logistics partner than for the organization that is receiving the return. In the return process, the outbound partner receives greater value as the result of the transaction (a credit or new product that is worth more than the product, assumedly in an unusable state, that is being returned), whereas the inbound trading partner may lose value in the transaction (the firm must forfeit a new product or credit in return for a product that is worth less).

The reverse logistics process may be seen as more of a cost center for the inbound partner and a profit center for the outbound partner. This phenomenon may be explained in the context of social exchange theory, which views the exchange relationship between specific actors as being contingent upon rewarding reactions from others (Blau, 1964; Homans, 1958; Miller, 2005). The exchange relationship may be viewed as less advantageous from the perspective of the inbound trading partner; thus, formalization of the process may not be as much of a priority for the inbound firm as it is for the outbound firm. We suggest that future reverse logistics research further examines the relationship between inbound and outbound trading partners to identify ways in which both partners can enhance value and cost position via reverse logistics.

Table 4
Results and model comparisons.

	Standardized coefficient		Δ
	Inbound	Outbound	
H1: IS capability → metrics	.223**	.216*	.007
H2: Goals → metrics	.289*	.578**	.289*
H3: Metrics → cost effectiveness	.148	.314**	.166*
H4: Metrics → processing effectiveness	.114	.222*	.108
H5: Processing effectiveness → cost effectiveness	.544**	.405**	.139
H6: mediating role of processing effectiveness	None	Partial	–
Metrics R^2	.137	.411	.274*
Processing effectiveness R^2	.022	.098	.076
Cost effectiveness R^2	.328	.270	.058

Notes: Coefficients are post-mediation.
** Significant at $p < .01$.
* Significant at $p < .05$.

Another contribution of this study is found in the integration of goal-setting theory and KBV. Goal-setting theory proposes that the setting of goals by organizations can lead to increased performance (Locke & Latham, 2002; Locke & Latham, 2005, 2006). The KBV holds that knowledge is a strategically significant resource that can be the basis for competitive advantage (Conner, 1991; Grant, 1996; Kogut & Zander, 1992; Spender, 1996). Our study of metrics suggests complementarities between these two theories and describes how metrics can be used as a mechanism for transferring and applying knowledge as a means to bridge the gap between establishing goals for reverse logistics and realizing performance therefrom. We recommend additional research at the intersection of these theories to further establish how metrics can be used to drive performance.

5.2. Implications for practice

Although we found no relationship between performance outcomes and metrics for inbound firms, metrics were shown to enhance cost effectiveness and processing effectiveness for outbound firms. Unfortunately, managerial and scholarly attention in regard to reverse logistics is often focused on the inbound process. Not only should more research examine the outbound side, but managers may wish to focus more attention on enhancing their outbound flow of products requiring return in order to better improve their cost position. As mentioned earlier, emerging take-back laws are reshaping the role of both supplier and customer in the supply chain, and especially in the business-to-business marketing environment. Customers are now charged with ensuring that products, such as electronic components, are properly dispositioned and do not end up in landfills. Because of this, there is an increased level of motivation for customers to formalize their reclamation and disposition processes, which will require managers and scholars alike to begin to view reverse logistics processes from several perspectives, as done in this study.

As with any business-to-business marketing relationship, both entities must work together to optimize shared processes and enhance performance; however, this research suggests that outbound firms are becoming more motivated to return products than inbound firms might be to receive them. Therefore, outbound firms may wish to consider instilling incentives for their suppliers to enhance return flows. Perhaps, because the roles are inverted for the reverse flow of products, similar incentive structures or contractual agreements that are common in forward logistics may help both parties to better meet expectations. For instance, agreed-upon service levels could be established, similar to what may be contracted for forward logistics flows. Just as it is incumbent upon the supplier in the forward channel to attract and retain customers via favorable terms, it may be just as important for customers to incentivize supplier to facilitate quick and effective returns processes. Doing so will make it easier for both parties to comply with emerging regulation and perhaps even achieve certification under ISO 14000 or similar standards.

In regard to establishing metrics for reverse logistics, our research suggests that organizations must set clear goals and have adequate information system support to measure and track goal attainment; this is true for both inbound and outbound firms. Because reverse logistics remains one of the newest facets considered under the umbrella of supply chain management, many firms may not have clearly stated goals or formalized reverse logistics processes. In fact, some of the participants surveyed in this study reported that their organization has not established any goals or metrics for reverse logistics. Consistent with some past research, this implies that these organizations' reverse logistics processes have a very low degree of formalization (Richey, Chen, Genchev, & Daugherty, 2005). Unfortunately, in the context of goal-setting theory, if firms do not first establish goals, then they may have

a difficult time improving their processes, and ultimately, their performance. Thus, our findings suggest that firms should look to establish goals for their reverse logistics processes, even if they traditionally do not handle a large volume of returns.

6. Limitations and additional research

There are some limitations to this study; however, each of these limitations may be seen as an opportunity to extend research within the topics of reverse logistics and supply chain metrics. To begin, our sample frame inherently limits the generalizability of our results. Although the United States Department of Defense supply chain is noted as being the largest collective supply chain in the world (Klapper, Hamblin, Hutchinson, Novak, & Vivar, 1999), it is surely not representative of all supply chains (e.g. retail). As such, the organizations sampled may provide a slightly different characterization of the reverse logistics exchange relationship. We encourage additional research to examine different sample frames, such as retail supply chains, commercial service supply chains, and supply chains based in countries outside the United States.

Next, our study is limited by the antecedents and outcomes chosen for investigation. Considering goal-setting theory and past research regarding reverse logistics and supply chain metrics, we feel that our selection of antecedents and outcomes was reasonable. However, there are additional variables that could be examined in the same or similar context. As mentioned in the Discussion and implications section, this research problem can be examined through the lens of additional theories to uncover more potential antecedents for future investigation. Similarly, additional outcome variables that are not necessarily limited to reverse logistics could be examined, such as additional measures of financial performance, trading partner relationship satisfaction, and agility. Furthermore, a similar conceptual model could be examined in the context of other supply chain and marketing functions outside of reverse logistics.

Our single-item measures (counts) of the goals and metric constructs present a limitation to this study; however, the significant results of this study indicate that this is an area worthy of further research using more comprehensive measures. As noted by Lapide (2000), there is a point of diminishing returns with regard to the number of both stated organizational goals and metrics employed to assess such goals, as measurement processes run the risk of becoming overly complex and more difficult to manage when too many are used. As shown in Table 2, the mean number of metrics employed by organizations surveyed was 1.56; in addition, only three organizations employed more than five metrics. Given that reverse logistics remains a non-formalized process within many organizations (Richey, Chen, Genchev, & Daugherty, 2005), it is assumed that a greater number of metrics explicitly stated by a participant would indicate a greater degree of commitment to metric usage, and thus still might be appropriate for this study. The same assumption was made for the measure of the goals construct. Although we would not necessarily recommend this measurement strategy for examining goals and metrics in all areas of the supply chain (i.e., more developed or formalized areas), we propose that it is a valid measurement technique for the purpose of this exploratory study. Nonetheless, we recommend future research in this area to develop and use more robust measures of goal and metric commitment, formulation, utilization, complexity and effectiveness (Austin, 1996). The use of these more comprehensive measures in future confirmatory studies will aid in building knowledge in this area.

Finally, most organizations within a complex supply chain will serve two separate roles when it comes to reverse logistics; they will receive product returns from their downstream customers and will also return products to their upstream suppliers. Traditionally, reverse logistics research has examined how an organization handles returned products from their customers. Our study is one of the first to disaggregate reverse logistics into two separate functions and we encourage more research to do the same. Specifically, the role of the customer (or as we termed, outbound) has been noted as being an important aspect of reverse logistics processes, yet has received little attention in the literature (Hazen, Hall, & Hanna, 2012). Investigation regarding how customers can maximize their cost position by enhancing their outbound returns processes may be a fruitful area for future research.

7. Conclusion

Chan, He, and Wang (2012) suggest that because of the value of reverse logistics, its role with respect to industrial marketing cannot be ignored. This research effort sheds light on the establishment of metrics as a means to formalize reverse logistics processes. Establishing metrics to manage processes is an important facet of effective supply chain management. We encourage scholars to continue to examine factors that can help organizations to develop, use, and derive value from metrics. Additionally, by decomposing reverse logistics into inbound and outbound functions, we found that the antecedents to establishing metrics (stated goals and information systems support) remained stable, yet the effect of metrics on cost effectiveness differs between functions. Because of these differences, we encourage future research within the domain of reverse logistics to account for the similarities and differences between the inbound and outbound functions.

Appendix A. Measurement items

Information system capability (Daugherty et al., 2002)

Please assess your firm's information systems used for reverse logistics in regard to:

1 Delivering accurate information within the organization
2 Having information available within the organization
3 Access to information outside of the organization
4 Sending information outside of the organization.

Cost effectiveness (Richey, Genchev, & Daugherty, 2005)

1 We incur lower compliance costs with environmental regulations because of our returns handling method.
2 Our strategy for dealing with returned merchandise improves our cost position relative to our closest competitors.
3 Our reverse logistics program reduces our cost.
4 We are realizing cost savings because of our reverse logistics activities.

Processing effectiveness (Richey, Genchev, & Daugherty, 2005)

Please rate the reverse logistics process in regard to:

1 Ease of obtaining return authorization
2 Handling reconciliation of charge-backs
3 Service timeliness for credit processing.

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