

THE DEVELOPMENT OF REVERSE LOGISTICS PERFORMANCE ASSESSMENT TOOL

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Introduction

Reverse Logistics has gained more popularity due to its dual benefits. It is an environmental friendly activity that, by the same token, enhances company profitability (Autry et al., 2001). However, in order to achieve those ideal advantages, the firm must have managed the reverse logistics efficiently, starting with a deep understanding on which efficiency degree the company currently stays in terms of reverse logistics. According to the literature, one of the basic problems encountered in reverse logistics management is the lack of relevant performance measurement and assessment tool. A performance assessment is essential to any process improvement as it allows an organization to better understand the current level of its performance and capability, and to know where improvement efforts should be focused (Sharahi and Abedian, 2009). However, the existing performance assessment tools proposed in the literature are complicated and require a fair amount of time to construct as they require each decision maker to set up criteria, dimensions and weights. In addition, the results of these tools tend to vary with decision makers (Tonanont et al., 2008).

This research aims at developing a practical and pertinent key performance measurement in reverse logistics that can reflect the efficiency level of each business activity the firm engages. This set of measurement is constructed based on an assumption that a firm is able to develop and modify its current system if and only if it understands its current performance. In this research, intensive secondary data analysis on numerous past research papers was conducted to identify essential reverse logistics activities and associated key performance indicators (KPIs). A performance assessment framework was developed and evaluated by experts to enhance its correctness and completeness. Finally, the tool practicality was examined through a pilot test. The proposed performance assessment tool can measure the true capability of the company in reverse logistics management by taking into accounts both qualitative and quantitative attributes.

Background and Literature Review

The Process of Reverse Logistics Management

According to the literature, there are 4 main cycles in reverse logistics management, including collection, return handling, recovery and disposal (Fleischmann, 2000; Pohlen and Farris, 1992; Blackburn et al., 2004; Wen-Jie and Zhi-Geng, 2007). Collection is a process of taking goods from customers back into the reverse logistics system. Return handling is a process that follows the collection process. It starts with product inspection and ends when the products are held, waiting for the recovery step. Return handling involves: (1) inspection; (2) disassembly; (3) cleaning; (4) sorting for further treatment; and (5) storing for further process as sorted.

Recovery begins when products are transferred to the recovery center and finishes when the products are returned back to the customers. Direct recovery involves reuse, resale and return to the suppliers. Indirect recovery, referred to as Part/Product Recovery Management involves repairing, refurbishing, remanufacturing, cannibalizing and disassembling. Disposal represents the process of getting rid of goods or parts, which are no longer reusable. There are two main types of disposal, including landfill and incineration (De Brito, 2003; Thierry et al., 1995; Wen-Jie and Zhi-Geng, 2007; Dyckhoff et al., 2004; Rogers and Tibben-Lembke, 1998).

Barriers to Reverse Logistics Management

Various barriers to reverse logistics management were identified in the literature, including competitive and legal issues, financial constraints, and lack of several essential supporting elements such as information and technological systems, appropriate performance metrics, and management inattention (Ravi and Shankar, 2005; Tan and Hosie, 2010; Rogers and Tibben-Lembke, 1998). To clarify this, lack of information sharing among supply chain members makes it difficult to identify end customers' need, which might lead to inefficiency in reverse logistics management.

Failure in reverse logistics management within an organization could also be caused by a lack of strategic or long-term plan, leading to having an operation without clear objectives. Since reverse logistics typically generates small return relative to the amount of investment, it is perceived not attractive to business managers (Ravi and Shankar, 2005; Autry et al., 2001; Gonzalez-Torre et al., 2010). However, one of the main causes of the failure is a lack of reverse logistic performance assessment tool. Having a practical tool would enable an organization to have a clear view of the overall operation direction and business potential, which is essential to operational improvement (Ravi and Shankar, 2005).

Performance Assessment Tool for Reverse Logistics Management

Some examples of performance assessment tool for reverse logistics management are: 1) Balanced Scorecard (BSC), a tool that gives the overall picture of a business through 4 essential dimensions; 2) Analytic Hierarchy Process (AHP), a multiple criteria decision-making tool; 3) Data Envelopment Analysis (DEA), developed for evaluating efficiency of return channels or other decision making units (Tonanont et al., 2008). It should be noted that these tools can capture only non-financial dimensions. Furthermore, they require careful consideration on individuals or decision makers' personal opinion or any subjective judgment which could affect the reliability of the result. Since each decision maker has to set up his/her own criteria, dimensions and weights, the resulting assessment of these tools tend to vary with different decision makers.

Framework, Criteria and Method for Reverse Logistics Performance Assessment

Huscroft (2010) and Richey et al. (2005) expressed their similar opinions on reverse logistics performance assessment that the framework and the criteria being used in an assessment should take into account the relationships among reverse logistics, resources commitment, internal innovations and other relating factors. Daugherty et al. (2005) used the Resource Based View theory as a framework for considering individual's available resources, and determining which resource creates competitive advantage in reverse logistics. Moreover, Yuen (2006) proposed the performance measurement and management of third-party logistics providers (3PL) using an organizational theory approach to elaborate the relationship between 3PL quality, organizational effectiveness, and relationship management with service partners. This paper stated the criteria to be used in assessing service quality, organizational effectiveness and relationship management. Examples of such criteria are reliability, customer service or customer satisfaction, and reputation of an organization. Keebler and Plank (2009) used triangulation approach, which collects data through a Delphi study, personal interviews and a questionnaire to determine critical factors that directly influence logistics process.

Based on the literature, criteria and methods of a reverse logistics performance assessment; as well as an assessment result which is unavoidable are based significantly on a decision maker's perception and background knowledge, not a fact. In addition, an assessment method is not a quantitative analysis, which cannot provide a clear numerical result.

Research Methodology

The objective of this study is to develop a set of performance indicators to be used as a standard tool for reverse logistics performance assessment. The tool is expected to cover all reverse logistics activities in both financial and non-financial dimensions. This research started with reviewing literature to get insights of possible logistics issues that were of importance to a company's reverse logistics performance. The secondary data extracted from the literature were used for Content Analysis. Subsequently, the data were organized by Systematic Review method to set up the scope of the research, specify the framework of activities in reverse logistics process, identify key dimensions in both financial and non-financial aspects, and finally develop key performance indicators that reflect the performance of reverse logistic management for each activity.

After the reverse logistics performance indicators were obtained, the next step was to conduct an expert judgment by interviewing 5 academicians and practitioners on the comprehensiveness and accuracy of the underlying indicators as to whether they are consistent with the dimensions and the content of an associated activity. The assessment on appropriateness of the indicators was conducted in the form of survey. The result of the surveys was summarized and analyzed by Index of Objective Congruence (IOC). Finally, the responses from these 5 experts were used as a guideline for enriching the quality of proposed indicators in terms of accuracy and comprehensiveness. Five criteria were used in selecting the experts, including: 1) Having an evidence of expertise; 2) Good Reputation; 3)

Availability and Willingness; 4) Understanding on related materials; and 5) No financial gain or personal benefit from participation. The chosen experts were not only willing to participate in the survey but also gave additional feedbacks and useful comments during the interview.

The final step of the study is to assess practicality of the tool, which is essential in the tool development process. The practicality assessment was done by expert judgment through a survey on a group of experts. The content of the survey is associated with several practical features including ease of use, cost of data collection, and accessibility of information. Then, a series of pilot tests using volunteer sampling to examine the functionality and practicality of the tool were conducted with a company operating reverse logistics. This process also includes interviewing the users for difficulties in utilizing the tool. The responses from the interviews were analyzed to determine the level of practicality and user-friendliness of the tool.

Development of Framework, Dimensions and Performance Indicators

Reverse Logistics Activities

A framework of reverse logistics has to be practical to support the assessment of reverse logistics performance. Specifically, it needs to be at such a practicality level that an evaluator could correctly implement it. Moreover, it should be widely accepted by academicians and practitioners in logistics and related fields. Although there exists some gap between a framework of reverse logistics and that of logistic, building a reverse logistics system could rely on the same concept of logistics (Chaves and Alcântara, 2006). In this research, the logistics activity framework proposed by Grant et al. (2006) is proposed with some modifications to make it align with the nature of reverse logistics. The reverse logistics activities and their corresponding stages are summarized in table 1.

Reverse Logistics Activity	Collecting	Handling	Recovery	Disposal
Customer Service and Support	Before Collecting Goods	-	-	-
Demand Forecasting and Planning	Before Collecting Goods	-	-	-
Part/Product Acquisition	Collection Center	-	-	-
Inventory Management	Before Inspection	After Handling	-	-
Material Handling	Before Inspection at Warehouse	After Handling at Warehouse	-	-
Packaging	Transport to Inspection	-	Transport to Recovery	Transport to Disposal
Transportation	From Customers to Inspection Center	-	From Handling to Recovery	From Handling to Disposal
Facilities Site Selection, Warehousing and Storage	Before Inspection at Warehouse	After Handling at Warehouse	-	-
Part/Product Recovery	-	-	Reuse, Resale, Return to Supplier, Repair, Refurbishing, Remanufacturing, Cannibalization, Recycling, Reclaim	-
Disposal	-	-	-	Incineration and Landfill

Table 1: The scope of reverse logistics activities

Source: Authors

It should be noted that Return Goods Handling and Reverse Logistics were not considered in this research as it involves the whole process that of consideration in the context of this research. Order Processing and Logistics Communications process was also excluded because, in reverse logistics, these activities are considered part of Customer Service and Support. Procurement and Purchasing is

changed to Part/Product Acquisition. In addition, Material Handling is separate from Packaging activity as these two activities appear in different stages of reverse logistics. Finally, Recovery and Disposal were added as suggested by the literature.

Key Dimensions of Reverse Logistics Performance

To specify key dimensions of reverse logistics performance, all factors influencing reverse logistics performance in both financial and non-financial aspects as appeared in the literature were gathered and categorized into groups. From the literature review, economical dimension represents the key financial aspect while environmental and customer satisfaction are the key non-financial dimensions (Byrne and Deeb, 1993 cited in Autry et al., 2001; Carter and Ellram, 1998; Wu and Dunn, 1995; Giuntini and Andel, 1995; De Brito and Dekker, 2003; Rogers and Tibben-Lembke, 1998 cited in Yellepeddi, 2006; De Brito, 2003; Subramaniam et al., 2004; Sasikumar et al., 2010 etc.).

Economical dimension is a business philosophy whose goal is to maximize profits through cost reduction and increase in revenue. Recapturing the value of returned products is one way to increase profitability. Moreover, efficient reverse logistics management can reduce inventory-holding, transportation and product disposal costs. The reason why organizations are concerned about the environmental issue is twofold, regulations and pressure from consumers in terms of environmental friendliness (Wu and Dunn, 1995). Many companies are forced by the regulations to recall their products to the production process. Consumers' concern on global warming nowadays becomes one of the most critical environmental issues because it is perceived to cause many adverse changes to the earth. So the company is demanded to properly accountable for this phenomenon (Rosier and Janzen, 2008). The last dimension, Customer Satisfaction, reflects the service quality, which can be measured through responsiveness (Subramaniam, et al., 2004; McIntyre et al., 1998; Genchev, 2007 etc.)

Development of Performance Indicators

The main objective of indicator development is to warrant that each indicator is practical and consistent with the dimension, to which it belongs. For the Economical Dimension, related performance indicators are derived from the concepts given in www.benchmarkingsuccess.com since reverse logistics system could be designed using the same idea as proposed for the forward counterpart (Chaves and Alcântara, 2006). However, modifications were made to better fit it with the objectives of reverse logistics. In forward logistics, the performance indicator of economical dimension is the percentage of logistics cost per sale or per margin while, in reverse logistics, the denominator is replaced by the total cost of reverse logistics management, comprising 10 activities. The reason of the change on the denominator is to allow a company to precisely examine the contribution of the considered activity to the total reverse logistics since the use of sales or margins may lead to a low percentage of logistics cost, thus making the improvement of cost performance unrecognizable. However, the traditional formula, the one using sales or margins, can still be used if preferred because increased profit is also the main goal of reverse logistics management (Rupnow, 2011).

With respect to the second dimension, Environmental Dimension, the performance indicator is a carbon footprint or the amount of carbon dioxide emission in kilogram or ton unit. One of the environmental problems that are concerned the most is global warming (Panchaiyo et al., 2009). The carbon dioxide contributes over 60% of greenhouse gas, which is a major cause of global warming. Reverse logistics activities release carbon dioxide in different ways. Activities such as Service and Support, Demand Forecasting and Planning, Part/Product Acquisition, and Inventory Management entail a large amount of electricity to power electronic devices used for communication with the customers, for forecasting, for contacting with suppliers, and for inventory management, respectively (National Science and Technology Development Agency, 2009). Generating the electricity causes carbon dioxide emission. In inventory management activity, electricity is used to light up buildings and powers air conditioners or heaters to control the temperature inside the warehouse (McKinnon, 2010). Packaging also involves carbon dioxide emission in the production of packages (Wolfgarten, 2011). Transportation and Material Handling use vehicles that consume fuel such as gasoline to function the engine (McKinnon, 2010). For disposal, the amount of carbon dioxide emission from incineration or landfill can be computed by the carbon dioxide emission formula, but note that the transportation back to the center, a backhaul or empty haul, also needs to be taken into account. The process of recovery is different from company to company, and thus the amount of carbon dioxide emission should be calculated according to the actual activity. As for the last dimension, Customer Satisfaction Dimension,

the related performance indicator is Responsiveness, which can be measured by the amount of time spent on each activity.

Tool Testing by Expert Judgment

Tool Validation

Validity of the tool was examined through a survey on a group of experts to ensure that the framework, the key dimensions, and the resulting key performance indicators can comprehensively and accurately assess the performance of reverse logistics management in both financial and non-financial aspects. Index of Objective Congruence (IOC) was used as an indication as to whether such conditions are properly met. Experts' suggestions were considered in the enhancement process such that the comprehensiveness and appropriateness of the measurement tool is further improved. After an assessment, the value of the IOC indicated that all the required conditions were met except for the one stating that the recovery and disposal are composed of only two components, transportation and packaging. To cope with this concern, the scope of activity was thus expanded to include all other related activities into the recovery and disposal process. Other issues raised in the survey were also addressed. For example, ambiguous definitions and unclear scope of activity were properly revised according to the experts' recommendation.

Tool Practicality

Similar to validity assessment, practicality of the tool was evaluated by experts' opinion. The objective of the survey is to determine whether the tool is easy to use, does not require much time for worker training, and does not require many efforts to understand and follow the computation of performance indicators. Moreover, the tool must be economical and the information required by the measurement tool must be accessible (Characteristics of Good Measurement Instruments, online; Ruengtrakul, online). The result of IOC on the assessment of the tool practicality showed that all conditions met the required criteria. However, there were some feedbacks from the experts towards the computation of the electricity usage in each activity as some information necessary for the calculation may not be available. To handle this concern, the use of activity-based costing was recommended.

Pilot Test

A pilot test with S.K. food (Thailand), Ltd., a canned fish production company was conducted to examine whether the proposed tool can be practically implemented under the real-world situation. The result asserts the tool practicality as the company could use the tool with short worker training session (approximately 1 day) and little effort to understand and follow the computation of performance indicators. It was noted that cooperation in information sharing within an organization is required to get the required information to complete the assessment tool. From the test, it was also found that most of the required information was accessible although some information was available only in the form of total value. Under such circumstances, the total value should be decomposed to obtain the right value as required in the assessment form. In conclusion, the performance assessment tool is adequately practical but needs cooperation across departments within the company in order to get all necessary data to complete the assessment form.

The reverse logistics activities, key dimensions and performance indicators for reverse logistics management assessment are summarized in the following table.

Processes/ Activities	Economical Dimension	Responsiveness Dimension***	Environmental Dimension
Collection and/or Return Handling			
Customer Service and Support	$\frac{\text{Customer Service Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	Average Turn Around Time (TAT) or <i>The time from customer service request to problem resolution</i>	Amount of electricity unit used in an activity x coefficient of CO ₂ emission of a country
Demand Forecasting and Planning	$\frac{\text{Demand Forecasting Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	Average time spent on forecasting and planning	

Part/Product Acquisition	$\frac{\text{Part/Product Acquisition Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	Average time spent on collecting "materials" until the "materials" arrive at the collection center or inspection center (different from case to case)		
	$\frac{\text{Customer Service Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			Average Inventory Days
Inventory Management	$\frac{\text{Material Handling Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	Average Material Handling Time		Quantity of fuel used for material handling x coefficient of CO ₂ emission of that fuel
Material Handling	$\frac{\text{Packaging Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	Average Packaging Time		Sum of the amount of materials used x coefficient of CO ₂ emission of that material
Packaging	$\frac{\text{Transportation Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	Average time spent on each transportation		Quantity of fuel used for transportation x coefficient of CO ₂ emission of that fuel
Transportation	$\frac{\text{Warehouse Management Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	Average Inventory Turns		Number of electricity unit used in warehouse x coefficient of CO ₂ emission of a country
Warehouse Management	Parts/Products Recovery			
Direct Options*				
Reuse	$\frac{\text{Reuse Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	The amount of time since inspection on whether to reuse resale or return a product to supplier until the product is delivered to the destination. For example, return to supplier is count since inspection started until a product is delivered to supplier.	Total amount of CO ₂ emission from fuel usage (the calculation is done according to transportation activity) and/or from electricity usage (refer to an activity with electricity for the calculation such as Warehouse Management)	
Resale	$\frac{\text{Resale Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			
Return to supplier	$\frac{\text{Return – to – supplier Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			
Recovery Options**				
Repair	$\frac{\text{Repair Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	The time that defects are detected until they are all completely removed. The unit of this value is day. The quality of a part or a product after correction can be either less or equal to that of a new product – depending on the level of fixing. (See more detail on each activity)	Recovery process is different from company to company, so a company should calculate the amount of CO ₂ emission according to their own process – thoroughly consider all possible CO ₂ emission that can incur during the recovery process.	
Refurbishing	$\frac{\text{Refurbishment Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			
Remanufacturing	$\frac{\text{Remanufacturing Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			
Cannibalization	$\frac{\text{Cannibalization Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			
Recycling	$\frac{\text{Recycling Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			
Reclaim	$\frac{\text{Reclaim Cost} \times 100}{\text{Total Reverse Logistics Cost}}$			

		production	
Disposal**			
Landfills	$\frac{\text{Landfill Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	The time since an inspection started and a product is decided to eliminate waste by landfill, take a product to the place where landfill is occurred until a product has been dropped at the landfill and the vehicle is back to the company.	Sum of (the amount of all different materials being buried(tons)x coefficient of CO ₂ emission of materials)
Incineration			
Open burning (Open air)			Quantity of materials burned(tons) x coefficient of CO ₂ emission from burning or
Incineration	$\frac{\text{Burning Cost} \times 100}{\text{Total Reverse Logistics Cost}}$	The time when an inspection is started, a product is decided to be burned, the product is dropped at the burning place, and finally the vehicle is back at the company.	Quantity of materials burned(tons) x coefficient of CO ₂ emission from generating electricity

Recommendation

Due to the limited time and information accessibility, the pilot test was conducted with only one company to assess the performance of the tool. Hence, the result may not be generalizable. Future research extension lies in having more interviews with both academicians and practitioners. Moreover, additional pilot tests with more companies in various industries should also be performed to increase the generalizability.

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