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Comprehensive performance measurement and causal-effect decision making model for reverse logistics enterprise ☆

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ABSTRACT

Product returns are becoming inevitable across all industries and returns can occur at any time during the product lifecycle. Consequently, the importance of reverse logistics (RL), has grown significantly in recent years. In order to maintain effective and efficient RL operations, enterprises adopt various approaches to improve their performance, such as Balanced Scorecard (BSC). In this research paper, a comprehensive RL performance measurement model is first developed by integrating BSC, and performance prism, thus, rectifying the drawbacks in previous frameworks while incorporating their strengths. Moreover, the RL performance is affected by different factors, for example resources utilization, productivity, and it is always difficult for decision-makers to improve all aspects at the same time. Another factor from the published frameworks assumes independence of performance factors. Nonetheless in the real world, such performance factors are seldom independent. In view of the constraint of various resources, this paper brings forward an important issue on how to enhance RL performance by clustering complex yet influential factors into groups to improve them in a stepwise way. To address this concern, an effective method called decision-making trial and evaluation laboratory (DEMATEL), is utilized. Considering the interdependence among these factors, the DEMATEL method produces a cause and effect relationship diagram. The performance factors are divided into these cause and effect groups, which enable the handling of inner dependences within a set of factors. The following proposed model contributes to enhance this RL enterprise performance, provides milestones for a performance measurement system design, and achieves targets of RL operations. Furthermore, the causal model development can help in the decision-making process as well as proposing suggestions to improve the enterprise performance.

1. Introduction

Reverse logistics (RL), has gained importance due to an increasing flow of returned products from customers. This high rate of returns is due to customer uncertainty that emerges from an impressive expansion of product choices and shorter product life cycles. Therefore, a significant impact on the corporate bottom line is inevitable (Thrikutam & Kumar, 2004). The incorporation of return flows is easier said than done, however, as the behavior of consumers introduces uncertainties in the quality, quantity, and timing of product returns. To restate, RL deals with the backward flow of product recovered from users. It aims at executing product recovery efficiently and effectively. According to Song and Hong (2008), in a time of globalization and an increasingly competitive environment, measuring performance has become critical to business success. From Kanji (2002), the first condition to improve and ultimately to achieve business excellence, is to develop and implement a system for performance measurement (PM). The term PM, is defined as the process of quantifying the efficiency and effectiveness of actions (Neely, 2002). Therefore, RL plays a significant role in the logistics system, however, the literature seldom discusses this RL performance and barely analyzes its influencing factors related to performance. Since the RL is a fairly new area of research, few PM frameworks and measures have been developed to evaluate it.

To continue, the literature presents these various popular PM frameworks, such as, performance measurement matrix, Balanced Scorecard (BSC), performance pyramid, Sink and Tuttle framework, European Foundation for Quality Management (EFQM) excellence model, performance prism (PP), and lastly, the Malcolm Baldrige National Quality Award (MBNQA) model, to name just a few. These PM frameworks provide the following: a balanced view between an external and internal focus (Keegan, Eiler, & Jones, 1989); results and determinants (Fitzgerald, Johnston, Brignall, Silvestro, & Voss, 1991); the four perspectives of the BSC (Kaplan & Norton, 1992); and, finally, the multiple perspectives of the stakeholders

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of PP (Kennerley & Neely, 2000). The newly developed PM frameworks highlight the importance of non-financial/financial measures, as well as internal/external factors (Bourne, Wilcox, Neely, & Platts, 2000), by providing an emphasis on the integration of the determinants (or drivers), and the result determines performance. In other words, performance has been presented in these two fundamental facets: the drivers of performance, and the results that are the performance outcomes. These two facets and their interconnection are the basis to understand PM. According to Bassioni, Price, and Hassan (2004), a performance measurement system (PMS), refers to the measurement system implemented by an enterprise, while a PM framework is a general theoretical framework developed in research that can act as the basis for a company's PMS. Researchers Garengo, Biazzo, and Bititci (2005), presented nine factors that are considered important to an effective PMS. They are: (1) strategy alignment; (2) strategy improvement; (3) focus on stakeholders; (4) balance; (5) dynamic adaptability; (6) process orientation; (7) depth and breadth; (8) causal relationships; and, (9) clarity and simplicity. Accordingly, many frameworks do not meet all the factors. While reviewing PMS in the context of small and medium sized enterprises, the authors concluded that the approaches developed in the last decades are more horizontal, process-oriented, and focus on stakeholder needs. In the literature, BSC has been repeatedly utilized where enterprises can link their performance to their RL practices. Due to recent corporate social responsibility and environmental legislation initiatives, RL enterprises (RLE), needs to constantly review the expectations of their stakeholders in order to achieve harmonious development between the environment, society, and the economy. According to Moullin (2003), PM assesses how well organizations are managed and the value they deliver to customers and other stakeholders. The BSC framework in the research seems to have overlooked certain other perspectives that might be of critical concern for PM of RL which needs to be investigated. A PMS determines the overall objectives and then provides a series of performance measures in order to achieve its objectives. Therefore, the major problems in designing PMS as a system involve: (1) The identification of a performance framework in which the performance attributes and relevant measures are not recognized; (2) the identification of the links between the required PM attributes and their factors; and (3) the performance measures to achieve the objectives.

According to De Waal (2002), the use of PMS can be categorized into three factors which are decision support, work integration, and communication. The decision support factor concerns the extent to which the PMS is used for first problem solving (that is, making sense out of data, and analyzing cause and effect relationships, etc.), second to explain and justify decisions, and third, to improve the effectiveness of the decision making process. In addition to all of this, PMS is also a process of allocating responsibilities and decision making, of setting the targets of performance, as well as providing the results of analyzing the achievement of the target (Cliville, Mauris, & Berrah, 2006). On the other hand, Pun and White (2005), argue that PM should facilitate the decision making to align actions with strategic objectives and provide feedback on operational performance and internal capabilities to the strategic level.

However, the quantification of the PM is closely defined by multi-attribute decision making (MADM) methods (Oztayşi & Ucal, 2009). In the opinion of Berrah and Cliville (2007), a PMS can be seen as a multi-criteria tool, made from a set of metrics. To accommodate the needs of this emerging field with interdisciplinary multi-criteria decision-making (MCDM) complexity, there is no doubt that designing a framework has always been a challenging issue. The holistic view of PM encompasses several uses that have been summarized by means of five elements: (1) decision-making (DM); (2) control; (3) signaling; (4) education and learning; as well as (5) external communication (Simons, 2000). The management of RL involves DM at multiple stages. Every stage involved in the network is interrelated in such a way that a decision made at one end affects the next stages of performance. Therefore, further research is needed to explore how the PM framework can be created and tailored to fulfill the unique measurement needs of a RLE, especially at both the strategic and operational levels. Furthermore, the quantitative analysis of RL performance is resolved by applying MCDM techniques.

As more and more enterprises are now aware that the management of RL enhances the competitive edge, RL requires a clear PM methodology. Since there is a lack of a comprehensive PM and DM model in the literature, this research study proposes a comprehensive reverse logistics enterprise performance measurement and decision making (CRLEPD), model by drawing on the literature in the areas of RL, PM, and MCDM. This integrated PM model is *comprehensive* because it addresses the following: (1) PM factors as previously defined by Garengo et al. (2005); (2) PM attributes (that is, the aspects that capture the PM holistically), such as strategies, processes, capabilities, perspectives, and measures; and finally, (3) understanding the RL behavior and its unique aspects, such as, product life cycle (PLC), and drivers. The CRLEPD is developed by considering existing PM approaches in RL context, investigating the basis for RL PM, and also understanding the inner relationship of various performance attributes and factors incorporated in the framework from a multi-criteria perspective.

The remainder of this paper now builds upon the understanding from Section 1 and is further organized as follows: Section 2 provides a literature review; Section 3 discusses the background of RL PM and presents the framework and methodology; Section 4 explains the model development and illustrates DEMATEL methodology. Finally, conclusions and implications are presented.

2. Review of literature

In this section, an overview of some relevant papers tackling RL is first presented and then an application of PM frameworks and utilization of DM methods will be discussed.

2.1. Reverse logistics

Rogers and Tibben-Lembke (1998), defined RL as "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal." Wang and Sun (2005), presented three distinct characteristics of RL, such as: (1) high uncertainties of supply on time, quantity and quality; (2) complexities in operations due to recovery options; and (3) barriers. Another researcher, Marien (1998), noted that a well-managed RL program can result in savings in the areas of inventory carrying, transportation, and waste disposal costs, and in improving customer satisfaction. According to Prahinski and Kocabasoglu (2006), the RL concept gives a focus on the activities involved in transportation, warehousing, and inventory management, in addition to the coordination and collaboration with channel partners. From the definition of RL, it is clear that RL operations does offer enterprises the possibilities of cost reduction due to the lower prices of raw materials and spare parts, and also extends the potential for more revenue by reselling materials and products, (Alvarezgil, Berrone, Husillos, & Lado, 2007).

Similarly, Huang et al. (2011), noted the importance of RL in extending PLC, creating new value, enhancing consumer relationships as well as supply chain partnerships, creating a positive