DIS Focused Approach for Product Recovery Process

A Proposed Flexible Return Management Model

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Abstract

This paper focus and evaluate the impact of information availability with respect to decisions is never concrete without taking DIS perspective. Therefore there is a need to understand the decision and information sharing scenario for product recovery process. For performance improvement paper proposes flexible recovery model with different facets of a product disassembly.

Introduction

Enterprises are now becoming aware of the importance of focusing their efforts on activities surrounding the return and processing of unused products.

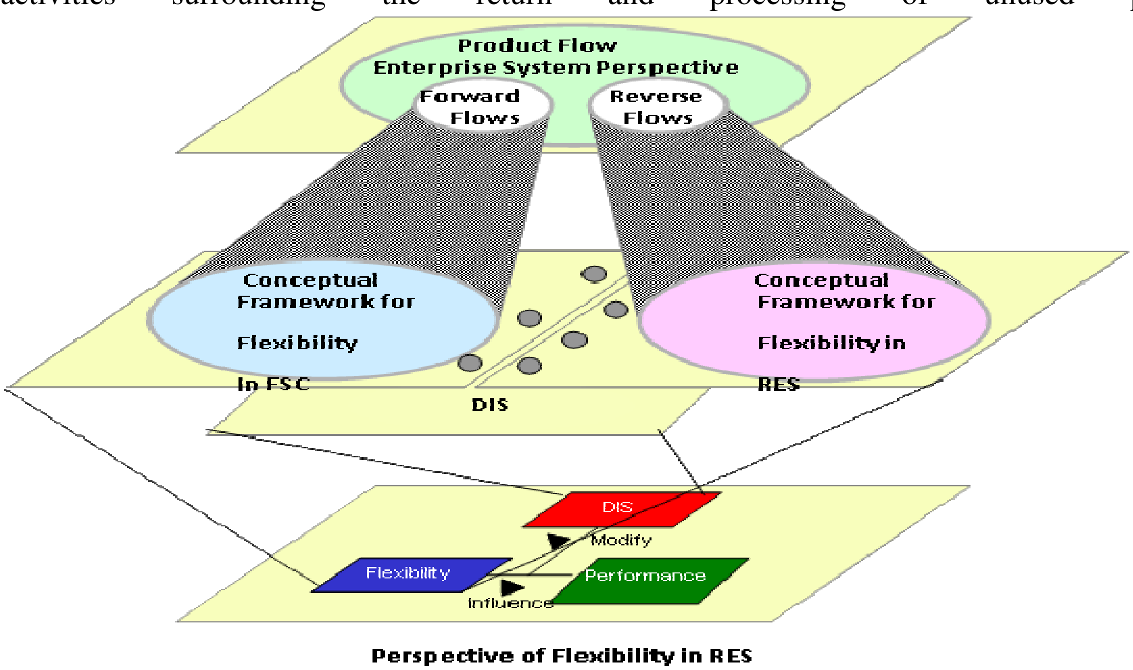

Figure 1. Framework of recovery system in DIS and flexibility perspective

They require to restructure, reorganize, support and plan these activities so as to make the present forward and reverse supply chain systems more flexible and efficient [10].

While focusing efforts on the returns of products and their processing, competitive decision and information strategies can be set up which, at various levels, will contribute to a better performance of current activities in the supply chain, concentrated until now primarily on the distribution of new products. The aim of this paper is to ensure clean and adequate distribution of recovered products along with the normal operation of the forward flow of products. This study looks further and demonstrates a systematic interoperability approach for modeling product recovery decisions, and in particular, synergies the role of product availability and quality information in improving the effectiveness of decisions in recovery process [11]. On refinement these strategies could further be used while choosing the recovery option for a returned product while designing a reverse enterprise system.

One of the most serious problems that the enterprises face in the execution of a product recovery process is the requirement of interoperable and robust decision and information systems [6, 15]. Product Recovery process is typically a boundary-spanning process taking care of returns between enterprises or of the same enterprise, thus proposing a model that has to work across system boundaries adds additional complexity to the problem. Therefore, flexible decision and information interoperability in a RES seems much more important to streamline return process. Returns information captured should be integrated with forward supply chain information to achieve optimum planning and reduction of costs [13, 14]. The whole support network can then be designed in a way that can serve both forward and reverse product/information flow efficiently as shown in figure 1. This is in line with the concept of designing an information system with an integrated product recovery decision system. The synergy of such information and decisions is the foundation and prerequisite for a recovery system that runs with high quality [1].

Flexible DIS model for recovery system

Product Recovery process can be now realized as a specialized area of an enterprises system which involves handling individual incoming returns, opening and inspecting products, communicating with internal departments, customers and vendors and then directing products into disposal channels that will provide the highest value[1,2]. Figure 2 depicts when and how decisions are to be made under various levels of information. However, from a flexibility perspective, the bigger issue common to all of those activities is how the enterprise should effectively and efficiently get the products from where they are not wanted to where they can be processed, reused, and salvaged. The firm must also decide the final destination for products inserted through a recovery system. To fulfill the need for this emerging field with interdisciplinary, multi-criteria decision-making complexity, designing a framework has always been a challenging issue [3]. With a high variability in evaluation of these alternatives with respect to other alternatives (either tangible or intangible), no pertinent data is available. A flexible interoperable Decision and Information system is required that can efficiently handle product recovery from the market.

In addition, considerable thought has to be given to reduce the overall costs in the whole process. The presence of multiple criteria (both managerial and technical (time/cost, market, legislative factor, quality, and environment impact)) and the involvement of multiple decision-makers will expand decisions from one to many dimensions, thus increasing the complexity of the product recovery process. The product recovery system so developed can help enterprises to prioritize and develop reverse manufacturing facilities accordingly, leading to a comprehensive reduction in overall costs [8,9].

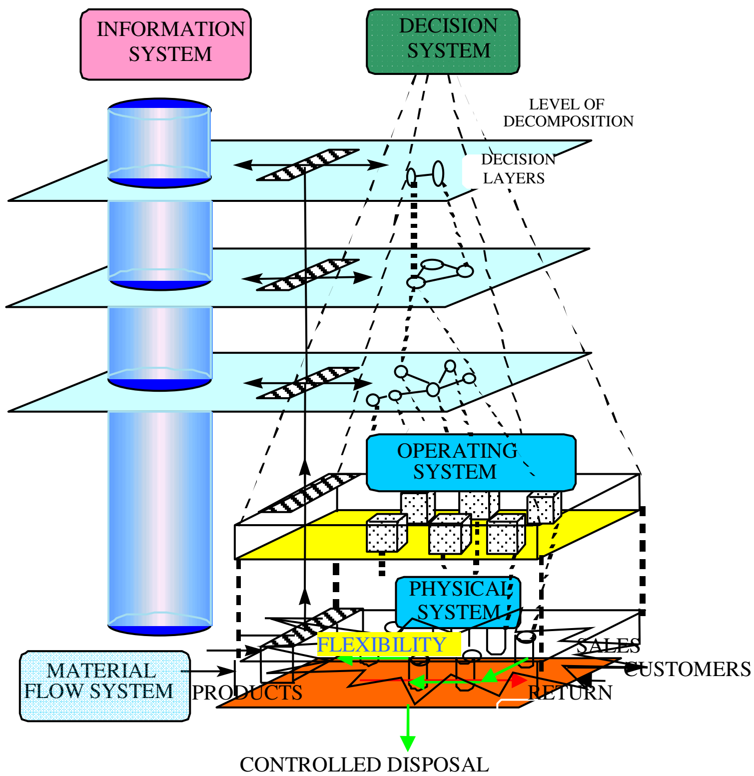

Figure 2. GRAI (Integrated Reference Model by University of Bordeaux – France) Motivated Model for Interoperable Decisions and Information in product recovery process [12]

In this connection, enterprises have to share and synergize decisions and information in the reverse supply chain in order to utilize correct information by a correct decision in correct time, because the production, transmission, processing and utilization of information are being flexibly distributed into all links to the system [13]. They must integrate the product recovery process process and design, coordinate, manage and control materials flow, information flow and fund flow among relevant entities involved in the product recovery, to improve the operational efficiency in processing the returns. DIS in product recovery process can be applied to manage and control materials flow and funds flow effectively [7, 8]. At the modelling level, we are focussing on frameworks and models for product recovery process that can be used to demonstrate the effect of various decision variables on improving performance.

Empirical model for decision and information relationship for recovery process

We define DIS in terms of the expected benefit achievable with the available information and decision sharing. Information is said to be complete when the state of the product can be known with certainty [5, 3]. This 'information' in the context of the product recovery decision can be defined as follows:

Let E represent the information already available to the decision-maker. $where \rightarrow \tilde{E} = E_k : (k = 1,2,....,n)$ Represents the set of product parameters [7].

Here e_i represent the list of parameter values that is measured in $\tilde{E}$ that support the decision regarding the state of the product (h_i). Therefore, decision-maker is said to have information regarding the state of the product for the purpose of making the product recovery decision if product observes all the parameters in the set $\tilde{E}$, given by the expression (1):

$$where \quad \rightarrow \quad p(h_i \mid \tilde{e}, E) = \begin{cases} 1, if \quad i = j \\ 0, \forall \quad i \neq j \end{cases} \quad (1)$$

If E represents the set of information already available to the decision maker the expected outcome that can be obtained when the decision-maker chooses the best recovery option for a product after obtaining enough information such that its state is known with complete certainty is given by (2):

$$where \rightarrow EU_E = \sum_{i=1}^{Nh} p(hi \mid E.\max_{dj} [u(h_i, d_i)] (2)$$

It provides the expression for the expected benefits that can be obtained with DIS delays. This leads to the expected benefit from obtaining complete information associated with a product returns. The expected benefit by reducing delays and selecting best recovery decision on time, EBI_E can be expressed as the difference between the expected benefits that can be obtained when the decision-maker chooses the best recovery option without delay (since its state is known with complete certainty) and the expected benefits of making the decision with delays (since its state is not known with complete certainty).

$$where \rightarrow EBI_E = EU_E - EU_E(d) \quad (3)$$

Essentially, above equation 3 presents a special case for previous expression, where $\tilde{E}$ reduces delays. The expected benefit of reducing DIS delays associated with the product information depends on the probability distribution that the decision maker has attributed to the status of product received and quality of information available. The maximum expected benefit that can be obtained from reducing DIS delays related with a product recovery is given by:

$$where \rightarrow EBI_{\max} = -\frac{\varepsilon_1 \varepsilon_2}{\varepsilon_1 + \varepsilon_2} \quad (4)$$

Here, ε_1 and ε_2 denotes the DIS delay penalties incurred due to erroneous decisions. Combining equations 3 & 4 we can deduce maximum benefit function in terms of penalties associated with DIS delays. Where the decision d_e has to be taken for best recovery option with delay on the basis of the available information E is given by (5):

$$where \rightarrow d_e = \begin{cases} d_1, if \ \ p(h_1 \ \ |E \geq \dfrac{\varepsilon_2}{\varepsilon_1 + \varepsilon_2} \ \ ) \\ d_2, if \ \ p(h_1 \ \ |E \leq \dfrac{\varepsilon_2}{\varepsilon_1 + \varepsilon_2} \ \ ) \end{cases} \quad (5)$$

This observation will be further clarified through simulation, which plots the maximum expected cost benefit that can be achieved from complete product DIS as a function of the delay with at varying operational flexibility levels. Further in this section, we examine how availability quality information associated with a returned product affects the decisions associated with the product's state; a generic representation has been shown as Figure 2. We initially scrutinize the basis of information on the state of products to decide on the basis of predefined parameters and then evaluate the value and reprocessing benefits. This will allow systematically take decisions for suitable reprocessing options. All these steps are continuously updating the knowledge base for future decision improvement.

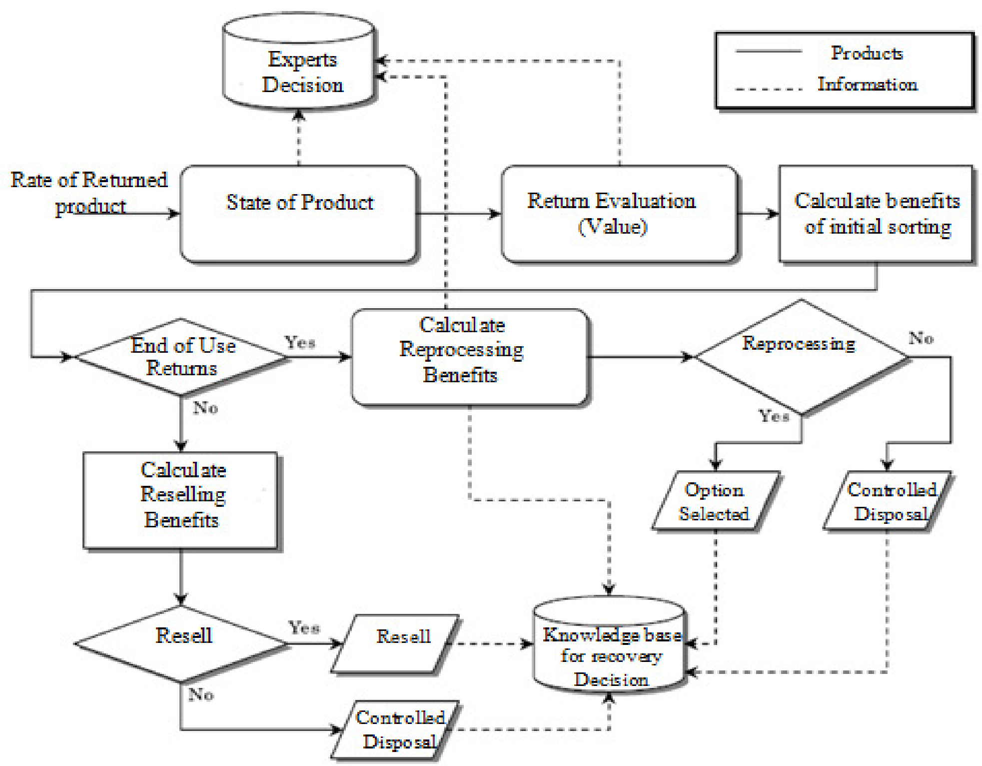

Figure 2. Generic Interoperable DIS Model for Product Recovery System

After understanding the decision and information interaction, we analyze the manner in which product recovery decisions are made and study the mechanics of the capturing value upon the sensitivity of the decision and information sharing process. The outcome of this sensitivity analysis is to combine understanding on how information and decision sharing, with and without delay, could result in a change in the optimal value recovery option for the returned product. Furthermore, the set of conditions under which a positive benefit from observing a product parameter can be achieved. The model demonstrates the actual benefits of the decision process against the percentage of parts processed, with and without DIS delays. Reducing the delays and improving decision-making during the initial nodes of the recovery process, considering the time value of the returned products, can obtain pragmatically consistent, as well as substantial performance improvement. Therefore, this strengthens the DIS role, particularly in the product recovery process.

Discussion & Conclusion

This paper has demonstrated the impact of different levels of information sharing, timeliness of decision sharing and the role of DIS delays and penalties on overall system performance. This study has illustrated the importance of DIS, which in turn affects the efficiency of product recovery operations. The low margins and increasing volatility of returned products make timely information and decision making a high priority. Additionally, useful tools such as radio frequency are helpful. New innovations such as two-dimensional bar codes and Radio Frequency Identification Devices (RFID) may soon be in use extensively. Technologies like bar coding and RFID help in making product recovery operations more effective and responsive.

Managerial Implications and future research

In the global competition, the fast changing nature of the customer demands (i.e. uncertainty) necessitates consideration of environmental concerns in designing efficient end-of-life product recovery system. The management product recovery processes thus can become the core concerns for practicing flexibility. Little research effort has been directed towards investigation with this as focus. Further suitable decision control mechanism is needed to be employed so that the value addition and extraction process is carried out efficiently. This paper is based on this notion to develop the flexibility construct and then demonstrate that such a construct is capable to define flexible product recovery process as a certain function of individual flexibility element as one of the objects of this research effort.

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