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KNOWLEDGE BASE QUALITY MODEL FOR FLEXIBLE REVERSE LOGISTICS SYSTEM

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ABSTRACT

Reverse Logistics comprises of all operations and decision making related to the reverse-flow of used products from customers to the manufacturers. It involves reuse of used products, remanufacturing or recycling, surplus inventory and packaging materials based on their configuration as well as condition. Excellent literature, related to quality modeling has been available for many years. A lot of discussion has taken place extolling the virtues of flexibility and its effect on the overall successful operation of enterprises. Considering in its generic form, quality based modeling can be applied to develop it as a flexible product recovery system. This paper examines the feasibility and practicality of applying a quality based self-assessment approach with a focus on flexibility for reverse logistic system improvements .It suggests that demonstration simulation models can play an important role in sharing the flexible work flow structures and the improvements in them. It is proposed that self-assessment based quality models to be developed to promote flexibility related issues, while dealing with the reverse logistics problems. One such model is presented and discussed in this paper.

Keywords: Reverse Enterprise System, Quality, Reverse logistics, Quality Models, Flexibility

Introduction

There is extensive research in the domain of developing reverse logistics with an ecological focus. Still not much had been talked about developing product recovery system for financial benefit. Developing product recovery system as a Reverse Enterprise Systems (RES) provides an integrated overview of the flexible manufacturing and logistics aspects of the product recovery with a view to achieve financial benefits along with added environmental benefits. RES employs the term reverse manufacturing for the manufacturing aspects that include remanufacturing, disassembly, planning, scheduling, and disassembly process planning. Logistics aspect of RES is usually called reverse logistics and is shown in figure 1. The ultimate success of any Enterprise will depend on its ability to participate in one or more successful organizations [Wadhwa & Rao 2002], as well as in its ability to integrate the enterprise's complex network same can be considered true for the RES. Self-assessment in reverse enterprise system effect performance because it establishes link between system performance recovery process considering the quality of returned products. Quality based self-assessment model can play a vital role in judging or assessing the quality of return products provided by the customer after different usage modes. It can also provide systematic evaluation of the performance of individual product recovery logistics and manufacturing functions. At the inspection stations, sortation specialists

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often lack the information they need to inspect and send product into the return chain effectively due to the inherent complexity of the recovery process. Self-assessment is a low-cost approach can well be used in these scenarios for monitoring the quality of returned products. Due to its simplicity and low cost application this tool becomes potentially important in developing countries like India. Self-assessment model for product recovery system is novel application to develop it as an enterprise system. It has been found that in literature that self-assessment is a prerequisite for maintaining professional competence of any enterprise [Das et al. 1998].Marienau [1999] identified few benefits associated with self-assessment that can be used for benchmarking decision for assessing state of returns: learning from experience, functioning more effectively, strengthening commitment to competent performance, and fostering self-agency and authority which motivates us to implement it for an efficient, effective and flexible decision making in reverse enterprise system. This paper also examines the issues related to green productivity, self-assessment, its knowledge-based implications and some results depicting improvement in performance through various levels of flexibility in reverse enterprise system, and its validity. The available literature also enriches the knowledge of self-assessment model which can further be extended for developing it as a RES. Knowledge Management (KM) uses advanced Information Technology to formally manage knowledge resources, which can further be used to facilitate the ease of reuse of return products though a centralized knowledge base to support decision especially at the sortation/inspection node. This paper also incorporates the application of appropriate technologies and sound management techniques to produce environmentally as well economically feasible products or services to bring about profitability. It makes recommendations for future research and concludes that while much remains to be done to assure that self-assessment model for flexible RES to cost-effective and easier to implement.

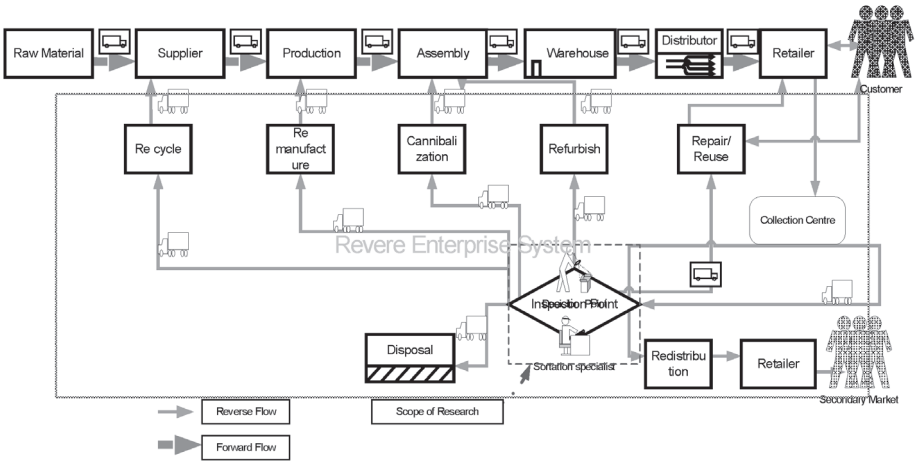


Figure 1: Generic View of Flexible Product Recovery as Reverse Enterprise System

Literature Review

Although products have been returned since the early days of commerce, reverse logistics has only attracted academic attention since the early 1990's. Hence RES being a new field, the use of terminology is not definitively established. In this paper we use the definition put forth by the European working group on reverse logistics, RevLog [1998].

The process of planning, implementing and controlling flows 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 value or proper disposal. Reverse logistics (RL) commonly refers to the backward movement of materials in the supply chain [Rogers and Tibben 2001]. This does not imply that materials are necessarily ending up at their original manufacturers, but refers to the collection of product returns, disassembly and disposal aspects of RL, regardless of their final destination [Carter and Ellram, 1998]. While some authors limit reverse logistics to the sum of those activities that ensure a sustainable or environment-friendly recovery of products and materials [Kopicki et al., 1993; Murphy and Poist, 2000], broader definitions extend this to the handling of all kinds of product returns, including the take-back of unwanted products, recalls and warranty returns [Stock, 1998; Rogers and Tibben-Lembke, 1998; Fleischmann, 2001]. Here we use the broader definition of reverse logistics as reverse enterprise system in the sense that we include products flowing backwards for all kinds of reasons. Furthermore, the terms 'product returns' and 'reverse logistics' are used interchangeably in this paper. A lot of previous research on product returns has concentrated on technical issues such as network design [Krikke, 1998], shop floor control (Guide and Srivastava, 1998) and inventory control [Inderfurth, 1997]. For a thorough review of previous research and gaps in technical aspects of reverse logistics please refer to Fleischmann [2001]. Most of the earlier work on reverse logistics deals with environmental. Surprisingly, though quality is a major consideration for returned products and services little has been written about quality and flexibility issues related to product recovery process [Guide and van Wassenhove, 2001]. Carter and Ellram [1998], and Stock [1998] contributed to the understanding of overall quality in reverse enterprise system. Thierry *et. al*. [1995] stated that the overall quality targets for remanufactured/ recycled products must, at the least, be equivalent to the new products. Customers usually expect the same level of quality from the re-processor regardless of the nature of the product.

While discussing some literature on self-assessment in 1977, Albert Bandura forwarded a theory of dealing with self-observation, self-judgment, and self-evaluative reaction [Levine 1980]. In other words, self-assessment involves observation and evaluation of behavior, and the reaction to this evaluation, which involves an interpretation of the performance of the whole enterprise rather than individual measurement techniques. The total quality management (TQM) literature contains numerous definitions of self-assessment, in particular 'Organizational self-assessment'. The following definition of self-assessment from the European Foundation of Quality Management is typical of the TQM literature: "A comprehensive, systematic and regular review of an organization's activities and results referenced against a model of business excellence" [Jackson 1998]. The TQM definitions differ from those of individual self-assessment in two important ways: TQM uses a model or standard and culminates in planned improvement actions [Jackson 1998; Pitt 1999; Jackson 1999]. In terms of reverse enterprises system, the use of a self-assessment model for performance is appealing and could easily be incorporated product recovery system due to non availability of comprehensive data regarding product usage mode as well as past data, thus increasing complexity. These issues can be handled and quality can be judge through some real life experience. These assessment methodology and practice-guidelines fulfilling the role of a performance model can structured in for of Knowledge base to ease out future decision demands for flexible recovery decision [Wadhwa et al., 2006]

Understanding Green Productivity for RES

Before Proceeding further this paper discusses importance of green productivity in studying quality model for product recovery as enterprise system RES. Economic development is facing an ever-increasing pressure due to depleting natural resources depletion and environmental quality degradation. Conventional way of doing business in neglecting the waste stream and striving for regulatory compliance means wastage of useful resources [Wadhwa and Madaan,

2007]. Human beings should learn and practice green productivity to achieve development in a more sustainable manner. Green productivity (GP) is the application of appropriate technologies and sound management techniques to produce environmentally compatible goods and services for simultaneously enhancing productivity and profitability. It signifies a new paradigm of socio-economic development aimed at the pursuit of economic and productivity growth while protecting the environment. GP first exploits the waste prevention and resource-use reduction opportunities and takes up treatment of residual levels of pollution to obtain a system improvement on environment. GP can achieved by the continuous application of quality based strategies to minimize the use of natural resources; prevent waste and emissions at source; reduce use and generation of toxic materials; and improve the economic and environmental performance of an enterprise. GP is applicable to the product recovery as well. Therefore, one should design flexible reverse enterprise system with the objective to attain sustainable development by continuously improving productivity of enterprises and environmental quality, both locally and globally.

Quality Based Modeling for Flexible Reverse Logistics System

The quality of the end-of-use/ end-of-life returned products is a significant parameter affecting the performance of reverse enterprise system. The product quality is not uniform unlike forward supply chain [Tibben-Lembke R.S., Rogers D.S. 2002]. Thierry et al. [1995] explained that the overall quality targets for remanufactured/recycled products must be, at the least, equivalent to the new products. Customers usually expect the same level of quality of product from the manufacturer regardless of the nature of the returned product. Rudi et al. [2000] describe the product recovery at the Norwegian national insurance administration. The Technical Aid Centers (TACs) had the task of distributing and servicing the wheelchairs, hearing aids, and speech synthesizers. Depending upon the product quality, they reused some units, repaired others, and refurbished the rest. When the returned products arrive at the distribution center, a decision must be made for its disposition. Gate keeping, a process of screening of the defective and unwarranted returned products at the entry point into the reverse logistics, is a very critical factor in realizing the entire reverse flow flexible and profitable. The quality of the returned product spreads over an assorted range. It could be faulty, damaged, or simply unwanted by the customer. Thus, there could be variations in the pricing of the products. The prices of the products in the forward channel could vary due to the factors like the quantity of the products purchased. Thus, in the case of the returned product, the pricing can be more complex as compared to the forward logistic system. The use of self-assessment model for pricing and performance can be taken as an integral part. This is appealing and could easily be incorporated into decision models for integrated each reverse manufacturing and logistics functions with a set of practice guidelines.

Role of Self Assessment Model for Flexible Reverse Logistics Decisions

This section of paper demonstrates the role of self-assessment model that can be well used to assess the performance product recovery system. In fact, this generic self-assessment model can well be used by enterprise dealing with wide verity of products in forward and reverse flows. Self-assessments can be conducted for many purposes, including determining how to improve performance [Jackson 1999], stimulate positive improvement to reduce returns, and evaluate the product recovery operations. The objectives of self-assessment have generally arisen from TQM initiatives and are focused on continuous quality improvement that is vastly needed in the field of reverse enterprise system. Here attention is given to identify strengths and areas for improvements and to develop self-assessment skills [Pitt 1999]. In many cases, efforts have been made to integrate almost all reverse manufacturing and logistics operation

at all levels to give a more flexible and complete representation of the services. Four major uses of self-assessment: identifying learning needs; improving performance; appraising performance; and reinforcing skills. In reality, these are not distinct categories—performance appraisal feeds into performance improvement, and identifying learning needs can lead to skill reinforcement. They are, however, useful distinctions for organizing the empirical evidence on self-assessment and identifying how self-assessment can improve product recovery as flexible systems [Wadhwa and Madaan, 2004]

- ***Identifying Need for Improvement in Reverse Logistics:*** Self-assessment helps management to delineate areas where they feel they need to improve their understanding of return process. The following problems have been identified in reverse logistics: (a) most logistics systems are not well-equipped to manage product movement in a reverse channel; (b) the costs associated with reverse logistics may be many times higher than moving the same product in a forward channel; (c) returned goods and products often cannot be transported, stored and/or handled in the same manner as in a forward channel. [Lambert and Stock, 1993] Inherent problems in returns present opportunities to identify needs to improve or reengineer the existing system.

- ***Improving and Measuring Performance:*** A performance measurement system is not simply concerned with collecting data associated with a predefined performance goal or standard. It is an overall management system involving prevention and detection aimed at achieving conformance to either internal or external customer requirements. Performance indicators provide organizations with the necessary information to make intelligent decisions. They are recognized as an important element of all continuous improvement programs. Performance indicators do not simply describe what has happened; they influence what will happen, as they provide information to decision makers. In this view, a well-designed performance management system is an effective tool for controlling business objectives.

Measurement can be used to achieve objectives through targeting the processes that support company objectives. However, measuring the wrong things in the wrong area or at the wrong level in an organization can prompt an inappropriate response and affect the ability to achieve objectives. In other words, by measuring the wrong things an organization is encouraging employees to do the wrong things. This is particularly evident if the measurement influences employees pay. Such an activity will pull the organization further away from their corporate objectives.

Traditionally, performance measurement reverse logistics has been confined to cost performance, which typically drove supply chain executives to manage the process of producing and distributing unit at optimal costs, while generating as few negative variances from standards as possible. As global competition has intensified, enterprises found that traditional performance measurement systems for supply chain were unable to account for the changes occurring in the business environment, and that the performance measures were not supplying the enterprise with the information it required to measurement systems that reflect the changes occurring in the business environment. Cost-based measures are no longer the only basis for decision-making in the reverse logistics operations. These contemporary performance measures of reverse logistics are based along other competitive dimensions such as effectiveness, efficiency, quality, timeliness, Green Productivity, safety, innovation, and environment. Here GP is achieved by the continuous application of strategies to minimize the use of natural resources, prevent wastes and emissions at source, reduce use and generation of toxic materials and improve the economic and environmental performance of a company. Maskell [1991] identifies a range of characteristics that can be attributed to such contemporary performance measures.

- They are directly related to the manufacturing strategy.
- They primarily non-financial measures.
- They change over time, as needs change.
- They are simple and easy to use.
- They are intended to foster improvement rather than just monitor.

For example in the present return process if we remove the shipping time from the customer transaction by having customers call first and use a scannable postage-paid label, information on the scannable label would allow the package to be sorted prior to its opening, based on the product line. This restructuring would make it possible for the merchandise to be handled and assessed by only one person. All of which creates an opportunity for redesigning the returns center in a way that increases the internal operating efficiency and performance of reverse logistics system.

• **Appraising Performance:** A number of studies look at the effect of self-assessment on the appraisal process, including formal performance reviews. Involving employees in their performance reviews is increasing as part of a more participative approach to management (Thornton 1980). The complexity of the reverse logistics process is due to the fact that there are hundreds of probabilistic activities, events, and man-machine equipments interacting within different sub processes involving a high degree of complexity. Self-assessment modeling can act as effective approach for process reengineering, particularly when the level of complexity is high.

Overall, it suggests that despite it low validity, self-assessment can be linked to improvement and appraisal of performance. It may be inferred that self-assessment provides an effective means for individuals and enterprise as a whole to reflect on their performance and devise ways to improve it as shown in figure 2. It also brings out the importance of increase in communication between the employer/employee and the enterprise system. This increase makes employees feel more in control of their performance. It also allows an accurate and effective study of alternative operational scenarios without costly and time-consuming evaluation function in both reverse manufacturing and logistics function. Increasingly, self-assessment is being viewed as an alternative for external monitoring and supervision, and as such, it falls within the context of performance appraisal.

• **Reinforcing Cognitive Abilities and Handling of Products after Return:** Self-assessment has been shown to sustain new behaviors learned during evaluation finding areas of improvement in returns. Use of self-assessment to improve cognitive abilities is not common; instead, efforts are geared toward identifying information needs. Where this is effective, self-assessment can reinforce cognitive capabilities and specific areas of knowledge in reverse enterprise system.

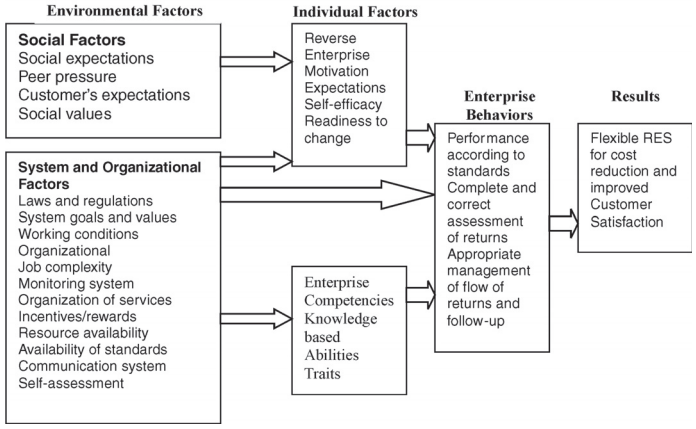
How Self-assessment is Conducted?

Self-Assessment is a comprehensive, systematic and regular review of an enterprise activities and results referenced against the EFQM model figure 3. The Model has four key ways which serve as a framework for the organizations to develop their vision and goals for the future in a tangible measurable way.

1. As a framework which organisations can use to help them and understand the systematic nature of their business and their key linkages to cause and effect relationships.
2. As the basis for the European Quality Award, a process which allows Europe to recognise

its most successful organisations and promote them as role models of Excellence for others to learn from.

3. As a diagnostic tool for assessing the current health of the organisation. Through this process an organisation is better able to balance its priorities, allocate resources and generate realistic business plans.



Figures 2: Determinants of Reverse Logistics System Performance

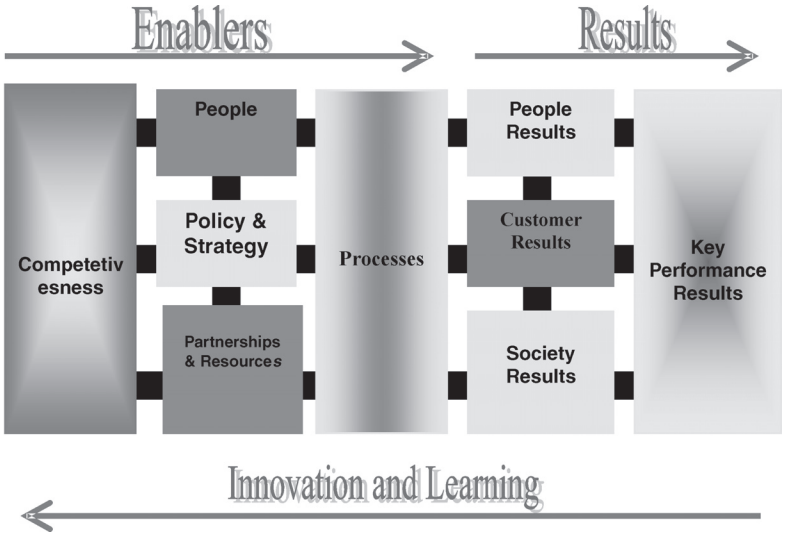


Figure 3: Generic EFQM Model

The fourth step is a diagnostic tool, known as self-assessment.The Self-Assessment process allows the organisation to discern clearly its strengths and areas in which improvements can be made and culminates in planned improvement actions which are then monitored for progress.Self-assessment involves a comprehensive and systematic approach for evaluating the current performance of all processes or activities in a reverse logistics system. Self-assessment is powerful diagnostic tool, which enables organizations to achieve business improvement and world-class standards [McQuarter et al 1998; Chiesa et al 1996]. The self

assessment process not only enables management to draw on existing knowledge, but also to apply it in a structured manner according to their priorities and concerns [McQuarter et al 1998]. The adoption of a self-assessment process to reverse logistics has found wide range of benefits.

- It provides rigorous, robust and structured approach to product recovery system.
- It is technique to review, focus and accelerate the rate of continuous improvement in management of returns.
- It is a means to achieve consistency of direction and consensus on improvement plans.
- It is a link to integrate reverse logistics and manufacturing functions.
- It also provides opportunity to promote and share best practice internally.
- It is a means to integrate various innovative initiatives into reverse logistics operations.
- It is a mechanism to focus and priorities improvements at various levels of return operation.
- A means of measuring progress over time through periodic comparisons.
- A way of involving employees at all levels to provide ownership and motivation for continuous improvement.

The process of self-assessment involves the identification of strengths and opportunities for improvement as the basis of improvement plans. However, programs for management of reverse enterprise system cannot be carried out successfully without a step-by-step system. This system should be organized, orderly and rationally, if change has to be embedded in the enterprise. Therefore, if RES has a clear understanding of what it is doing and why, and if it has an established mechanism in place to initiate and undertake improvement, KM can facilitate change to happen quickly and predictably. Where such an infrastructure is not in place, it has to be put in place for each initiative. The goal of self-assessment with KM view methodology in reverse logistics operations is to identify and integrate the return functions with forward chain.

IDEF0 model is used to illustrate the improvement methodology. This technique is specifically designed to enhance communication by using diagrams based on simple box and arrow graphics. Activities are described in terms of their inputs, outputs, controls and mechanisms. This helps the user to identify what activities that are performed in reverse logistics operations, and what is needed to perform those activities using KM views. The methodology consists of a set of steps to be accomplished, and each step has various considerations and knowledge management makes these steps successful. While a methodology does not provide an organization with all the answers, it does provide a framework on which they can develop and define their own innovation processes. This Methodology provides a structure; through which reverse logistics can manage and coordinate their improvement process and grades are awarded out 200 for each step. The five stages in the methodology are briefly outlined in figure 4.

- **Analyze Environment and Identify Best Practices for RL and Green Productivity:** In this phase, we will consider activities (e.g. benchmarking audits, competitor analysis, gap analysis etc.) to observe the changes in given process and hence serve the cause of acquiring knowledge. Following gaps have been identified viz. most logistics systems are not well-equipped to manage product movement in a reverse channel; the costs associated with reverse logistics may be higher than moving the same product in a forward channel; returned goods and products often cannot be transported, stored and/or handled in the same. Such activities will enable reverse logistics to analyze the environment in order to identify opportunities to enhance their strengths and capabilities. Here we analyze and

give grade A1 to this stage out of 200

- **Generate framework for Measure of performance (MOP) for returns consulting all:** We generate framework for returns by consulting every aspect of the return chain. From the analysis undertaken in the first stage, a model or framework of reverse logistics present opportunities to develop new reverse distribution processes or reengineer the existing ones with the primary objective of enhancing customer service quality. A secondary objective is to explore opportunities for increasing operational efficiency and share knowledge at all level. Questions associated with each of these opportunities are then developed which can be used to evaluate the reverse manufacturing and logistics activities with respect to each of these best practices. Here we share knowledge at all level in reverse enterprise system. We also award marks A2 to this stage out of 200.

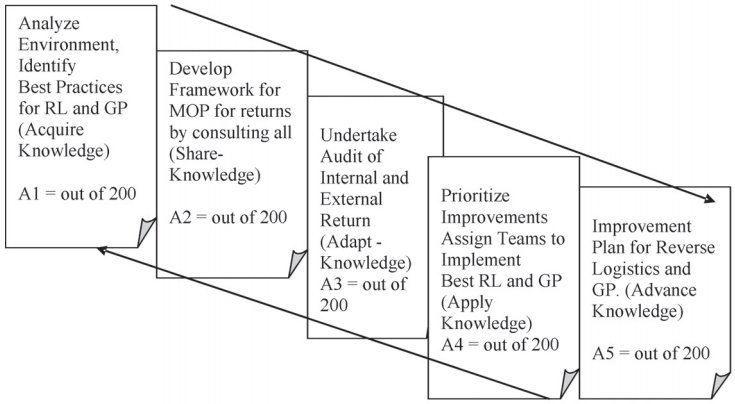


Figure 2: Self-Assessment Methodology for Reverse Logistics and GP Enriched with KM

- **Undertake audit of external and internal returns:** This stage helps to overcome any resistance to change by securing the commitment and support of all concerned i.e. management and employees. Employees can take ownership of the change initiative by undertaking the audit. By doing this they will understand, adapt knowledge and evaluate the existing practices and be in a position to identify potential areas for change. This stage is evaluated A3 for grades out of 200.
- **Prioritize improvements and assign teams to implement RL and GP:** Project prioritization is used as a basis for ranking projects in order to determine how significant a particular improvement in reverse logistics and green productivity is in meeting the organization's goals relative to others in the portfolio. Like reducing the cycle time of customer receipt of the refund or exchange, and increasing the convenience in sending a return. Specific teams are assigned responsibility for application of knowledge and accountability to individual projects on the reengineering the present reverse logistics operations. Here we assign A4 out of 200.
- **Implement improvement plan for RL and GP:** The projects on the improvement plan are implemented as individual projects, in accordance with the traditional processes of project management and the internal procedures of advancement of knowledge. This phase of the activity is the most visible, time consuming and labor intensive part of the methodology. In the spirit of implementation of improvement plan; Knowledge management explores new

opportunities to enhance customer satisfaction with the returns process. Here we assign A5 out of 200

By the use of computer based self-assessment model; the analysis can be acceptable at all levels of reverse logistics and GP improvement operations and it is also easy to use. Self-assessment can used to identify strengths and weaknesses, and are sometimes used for recertification of sortation specialist at the inspection point in reverse logistics operation. Self-assessment, with reference to knowledge management, is to be used as a part of quality improvement/assurance efforts; it should provide a knowledge base to handle different return situation efficiently and information about the quality of services. If it can lead to improvements in the quality of services, it will be an even stronger tool.

Conclusions

Much research on self-assessment and KM has been done for understanding the issues in forward supply chain system while little has done focusing reverse logistics settings. In addition, as indicated in other sections of this paper, there is little conclusive evidence regarding self-assessment and the best way to incorporate it into flexible return functions; additional research is clearly needed. The potential benefits from using knowledge-based self-assessment may play an important role in and enriching developing quality assurance in flexible reverse logistics. It may be a lower-cost evaluation mechanism than many others and relatively easy to implement. Because it is linked to self-direction, it may also be the most appropriate tool for learners. There are reports that it can enhance and improve communications between management and other staff. While significant work still needs to be done to determine the contexts and methods through which self-assessment will have the most impact on reverse logistics, it is potentially a valid tool for self-evaluation that deserves further utilization and attention.

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