Application of Reverse Logistics for Remanufacturing in Electro-Mechanical Industrial Sector

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ABSTRACT

Recovery strategy is one the practical methods which supports sustainable objectives. Environmental policies and legislation, economic benefits and increasing customer awareness of green products are the main drivers for the extension of recovery strategies in the industrial and service sectors. Remanufacturing is preferable to recycling due to the saving of the initial value added to the raw material in producing the final product. Remanufacturing is "The process of returning a used product to at least OEM original performance specification from the customers' perspective and giving the resultant product a warranty that is at least equal to that of a newly manufactured equivalent". The steady supply of core product is critical for remanufacturing as without it, it clearly cannot proceed. The complexity of the remanufacturing process lies in the uncertainty in the timing, quality and quantity of used products. The movement of used products from the consumer to the producer in distribution channel is defined as reverse logistics. Through reverse logistics activities, the assessment of used products is important to the overall profitability of the remanufacturing process. The decision for accepting or rejecting the used product is based on suitability for remanufacturing and is made by the dealers or OEM. Due to the lack of assessment criteria and guidelines for the assessment process, the used product assessment may be erroneous and it depends almost entirely on the experience. This paper will describe the previous work in the reverse logistics for remanufacturing. Also, it will present a proposed model showing the interaction between remanufacturing processes and reverse logistics activities. Finally, it will propose the research objectives and methodology which focus on the assessment criteria of core products and the relation between the nominal quality and acquisition price of used product. It present the initial findings of conducting industrial case study in Egypt.

1.INTRODUCTION

"Remanufacturing is the process of returning a used product to at least OEM original performance specification from the customers' perspective and giving the resultant product a warranty that is at least equal to that of a newly manufactured equivalent" [41]. Many authors pointed out that the main drivers to the growth of remanufacturing as organized industrial sectors in many countries are as follows [7, 41, 35, and 3]:

- Legislation or take-back obligation issued by the European Union to push product recovery such as: WEEE, RoSH directive and EuP directive on the eco-design of energy-using products.
- Economic benefits by saving material and, energy cost.
- Market demand for cheaper products
- Increasing customers awareness for 'green' products and companies

Since the end of the 1970s, many authors have highlighted the ecological, social, and economic benefits of remanufacturing. Because of benefits, remanufacturing is considered a successful strategy for developing sustainable manufacturing. Past work gave examples of the best practice in remanufacturing strategy in the electro-mechanical sector [27, 29].

The process of remanufacturing became clarified when Ijomah developed a generic model of the remanufacturing business model, illustrating the activities of remanufacturing and their inter-relationships [40]. The activities are receiving core (used product), clean and strip the core, investigate the core, component

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remanufacturing and inspection and testing. The author declared that the supply of the core (the used product), is critical for starting remanufacturing because it cannot proceed without used product to remanufacture. Also, if the supply of used products is inadequate then remanufacture, when it is able to proceed, must rely on new components rather than components cannibalized from used products [40]. Consequently, designing effective and efficient reverse supply chain system is a prerequisite for remanufacturing and a key driver for providing the economic benefits necessary to initiate and sustain customer relationship and customer loyalty [37, 4].

2.REVERSE SUPPLY CHAIN/REVERSE LOGISTICS ACTIVITIES

Pohlen and Farris define Reverse Logistics, guided by marketing principles, as being: “The movement of goods from a consumer towards a producer in a channel of distribution” [19]. Rogers and Tibben-Lembke describe Reverse Logistics 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 value or proper disposal” [34]. Other authors state that reverse supply chain processes can be organized sequentially in five steps: product acquisition, transportation and warehousing, inspection, recovery process, and distribution and sales [23, 4, 37, and 26].

Starting with the acquisition process, Guide and Wassenhove state that product acquisition management is a key input to assessing the potential economic attractiveness of remanufacture activities [14]. This process is responsible for core acquisition in order to ensure adequate supply of cores for remanufacturing. As well, the authors rejected the idea that the firm should accept all used product returns from waste stream and show that a system for acceptance control exists. There are three major sources of used products [4]: Forward supply chain such as returns from defective or damage products and product recalls, Market driven systems, and Waste stream.

In a market driven systems, the used products returns to OEMs, retailers, dealers and third parties from the customer using different financial incentives policies such as, deposit based, credit based, buy back. Through those incentives companies are willing to obtain higher quality products for a fee. Consequently, there is less variability in the quality of used product. Large numbers of firms acquires cores directly from the customer (81.8%) by applying a trade-in or credit strategy when a remanufactured product is purchased. Those firms noticed that customer were motivated to return the products by themselves [4, 14]. Ostlin has defined other incentives such as ownership-based, service contract, direct order and voluntary based [12].

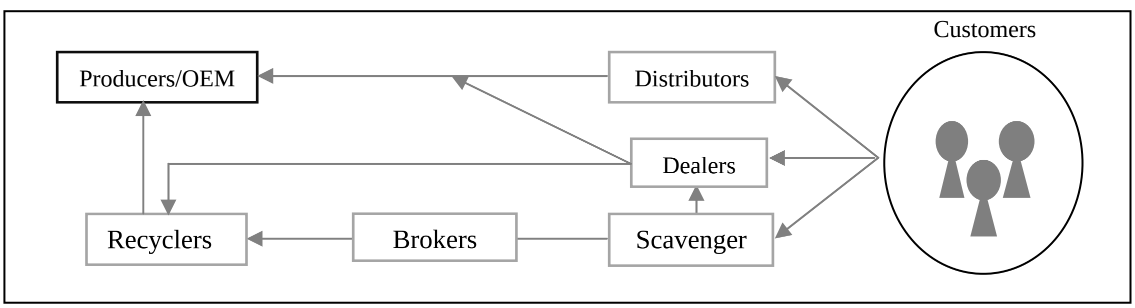

Figure 1: Possible channels contributors on the reverse supply chain according to Prahinski and Kocabasoglu [4]

The cores are assessed in order to ensure their suitability for remanufacturing and if credit incentive is applied the price regarding to the quality of the cores are determined. Most likely, this assessment is done by the retailer or dealers. Ijomah clarified that the examination of quality of the components that make up the core are very important. Because inadequate components assessment have significant negative financial repercussions such as the discarding of good components and the use of inappropriate labour. Although, core assessment is critically important, there are a few guidelines to assist accurate component evaluation leading to excessive dependence on the experience of labours [40, 41]. The author identified the problems resulting from the shortage of documented assessment criteria and procedure as follows: inconsistency of parts inspections, excessive waste, inadequate training and poor performance monitoring. Moreover, Guide and Wassenhove claimed that the relation between nominal quality levels and acquisition price of used product should be identified in order to facilitate the effective management of core acquisition [14].

The model in figure 2 shows the interaction between reverse logistics activities and the remanufacturing process starting and demonstrates the decision points in the whole process. The model has been developed by the author from the literature and is based on two existing models: the framework for reverse logistics and a generic remanufacturing process flowchart [34, 40].

The first model of Mitra which similar to the frameworks presented by Fleischmann and Bloemhof-Ruwaard [23, 13] was selected because the model was developed upon survey on considerable number of case studies in different industries which address the design of logistics networks in a product recovery context. The model identified the recurrent reverse logistics in product recovery networks. The second model is selected because it obviously demonstrates the remanufacturing processes in details. The model validated by over 20 remanufacturing companies. Therefore, the model became a generic model for remanufacturing. The proposed model will be developed through conducting in-depth investigation of the case study.

3. Previous studies of the Reverse Logistics

The research done in reverse logistics (RL) is mostly in practitioner-related rather than academic journals. Fleischmann notes that the literature is divided into three research areas: distribution planning, inventory control, and production planning [24]. In contrast, Dowlatshahi classified the literature according to five categories: global concepts; quantitative models; distribution, warehousing and transportation; company profiles; and applications [34]. The author stated that “the majority of the articles show lack of depth, do not describe the basic structure of Reverse Logistics, and do not define the basic concepts and terms". Then, attention to the literature and the strategic and operational factors in Reverse Logistics systems is listed by the author. Most of scholars addressed the reverse logistics for recycling and a few for remanufacturing [15]. The following literature investigates only previous studies of Reverse Logistics network for remanufacturing.

3.1. Quantitative Analysis

Simulation is a common method that is applied in quantitative methods. The method of system simulation rapidly and conveniently assesses various comprehensive reverse logistics networks under different scenarios. Consequently, an optimized network structure may be decided. Quite a few mathematical models are proposed in various literatures to optimize reverse logistics system. Fleischmann reviewed the previous quantitative models for reverse logistics network [24]. Jayaraman [38] established a mixed integer programming model that simultaneously solves for the location of remanufacturing/distribution facilities, the trans-shipment, production, and stocking of optimal quantities of remanufactured products and cores. The authors discussed the managerial uses of the model for logistics decision-making.

Krumwiede and Sheu developed a reverse logistics decision-making model to guide the process of examining the feasibility of implementing reverse logistics in third-party providers such as transportation companies [5]. Lourenço and Pablo developed a medium term production planning model dealing with the two new concepts: Partnerships and Reverse Logistics [10]. Jayaraman proposed a mathematical programming model for the management of product return flows, induced by various forms of reuse of products and material [37]. Pochampally proposed a newly developed method called physical programming to identify potential facilities in a set of candidate recovery facilities operating in a region where a reverse supply chain is to be established [17].

Savaskan addressed the problem of choosing the appropriate reverse channel structure for the collection of used products from customers for remanufacturing [31]. The authors modeled the three options for collecting the used product namely from the manufacture, the retailer and third party. The authors found that the most effective method of product collection activity for the manufacturer is the retailer. Beamon cited by Mutha and Pokharel have developed an integer programming model for a four level reverse supply chain by assuming infinite storage capacities and same holding costs for recovered and new products [2,1]. In the same year, Kusumastuti proposed a multi objective and multi-period mixed integer linear programming model for network design for modularized products. The authors used the model to determine the number of existing forward flow facilities and the number of dedicated facilities to be set up for handling return flow [28]. Kim have proposed a general framework for remanufacturing environment and a mathematical model to maximize the total cost savings by optimally deciding the quantity of parts to be processed at each remanufacturing facilities, the number of purchased parts from subcontractor [16].

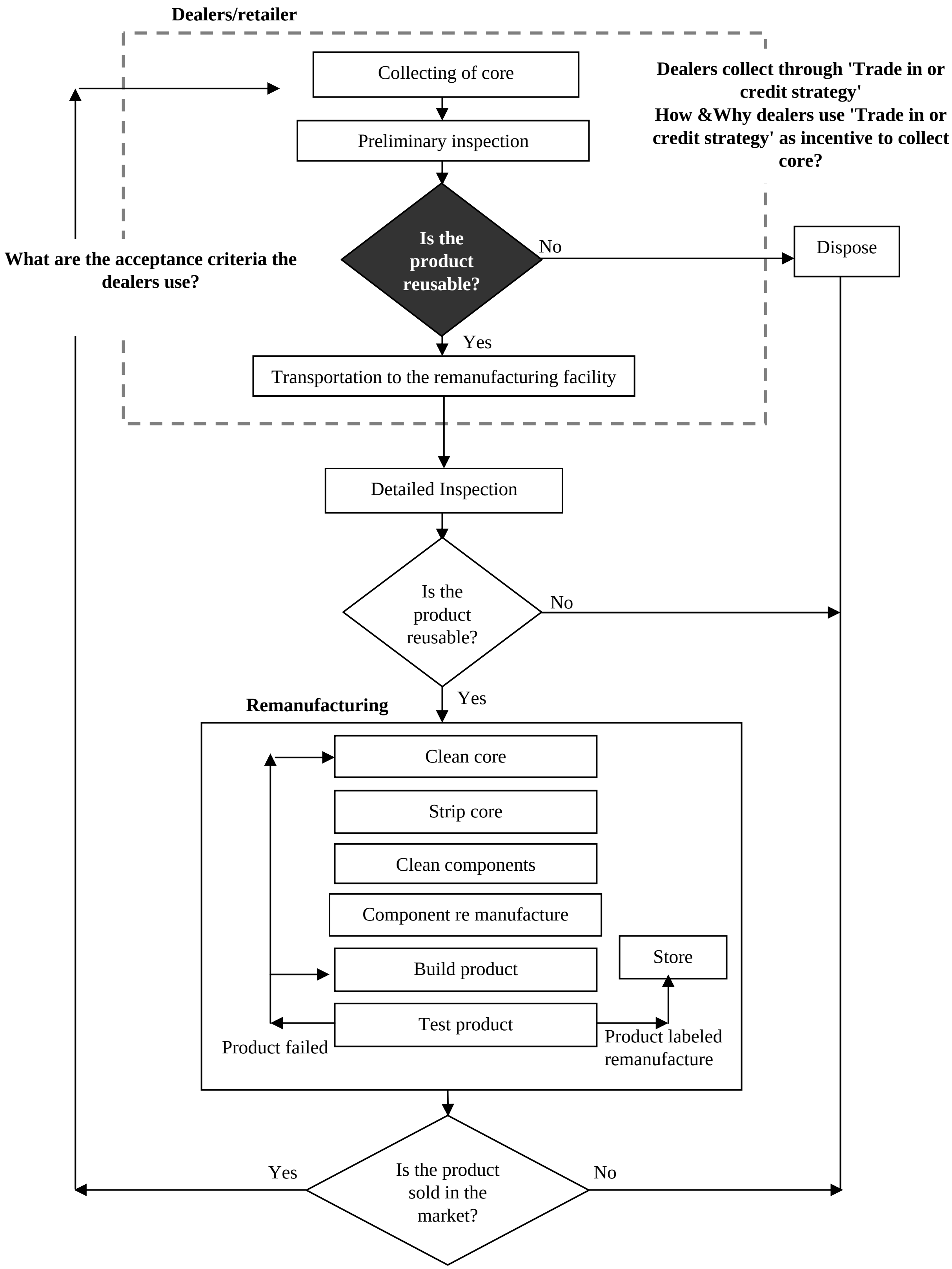

Figure 2: Proposed model demonstrates the interaction between reverse logistics activities and remanufacturing based on Mirta [34] and Ijomah [40]

Kara has presented a simulation model of a reverse logistics networks for collecting EOL electrical appliances in the Sydney Metropolitan Area [18]. The simulation results showed that the model calculates the collection cost in a predictable manner. Moreover, it provides a tool to understand how the system behaves by carrying out what-if assessments. Finally, the authors suggested that the low cost can be achieved when local councils act as collectors. In the same year, Listes proposed a generic stochastic model for the design of networks comprising both supply and return channels, organized in a closed loop system [26].

Lu and Bostal proposed mixed integer model to solve a two-level location problem with three types of facility to be located in a specific reverse logistics system, namely a ReManufacturing Network (RMN) [42]. The model considers simultaneously the forward and reverse flows and their common interactions. Wojanowski presented a continuous modeling framework for designing a drop-off facility network and determining the sales price that maximize the firm's profit under a given deposit–refund [30]. Lee and Dong have developed a deterministic programming model for systematically managing forward and reverse logistics flows [30]. Srivastava provided an integrated holistic conceptual framework that combines descriptive modeling with optimization techniques at the methodological level [36].

QUALITATIVE ANALYSIS AND CASE STUDIES

De Brito reported that there are more 60 case studies for reverse logistics for different recovery processes. Approximately 60% of the cases are in the manufacturing category; about 20% are within wholesale and retail trade and about 10% in construction. However, to a certain extent a few authors investigated reverse logistics network for reverse logistics for remanufacturing field using case studies. It is observed that almost half of them deal with metal products, machinery and equipment and the majority of the cases are on products with high value [21].

Thierry declared that Recovery options that need take back of product may be classified as two kinds: direct recovery and process recovery. Recovery options can be summarized from various publications as: reuse, repair, remanufacturing, recycling and disposal [25].

Dijkhuizen discussed the remanufacturing network of IBM. The author dealt with the problem of where to re-process the products: in each country, or centrally at one place in Europe [9]. Meijer discussed the remanufacturing of used scanners, printers, copiers, faxes at Canon [8]. Krikke analyzed reverse logistics for remanufacturing of photocopiers [11]. The authors proposed a multi integer linear programming model to determine optimal location for preparation and reassembly operations. Guide clarified that some suppliers for toner cartridges, including UNISYS, deliver their cartridge in a box that can be returned for free to them or via another third party logistics service provider like Hewlett Packard or Xerox [15]. Also, Guide and Wassenhove discussed acquisition price incentive through a U.S. cellular phone remanufacturer that is also very active in setting prices to buy used mobile phones in the Business to Business environment [14].

Toktay et al described special example of service returns on Kodak's single use camera. The authors proposed a closed queuing network model to determine a cost-efficient order policy for the external supplies. Major difficulties are largely unknown and difficult to observe from return probabilities and market distribution [20]. They assessed the importance of information on the returns for the control of the network. Fleischmann et al answered the following question: What activities are involved in reverse logistics? The authors identified main differences between the recovery networks: links with other networks; open vs. closed loop structure; and degree of branch co-operation. Moreover, they pointed out the classification scheme for different types of recovery networks: bulk recycling network; assembly product remanufacturing network; and re-usable item network. The authors proposed generic facility location model which is used to analyze the impact of product return flows on logistics networks [22].

De Brito and Dekker answered the following question: Why do companies pursue reverse logistics? The authors categorized the driving forces under three headings: Economics, legislation and extended responsibility. Additionally, reverse logistics is the main source for supplying used products for the companies in order to establish product recovery actions such as remanufacturing [21]. Ravi et al presented an analytic network process (ANP) based decision model to analyze the options in reverse logistics (RL) for end-of-life computers and link them to the determinants, dimensions and enablers of reverse logistics (RL) [29]. The model links the financial and non-financial, tangible and intangible, internal and external factors, thus providing a holistic framework for the selection of an alternative for the reverse logistics operations for end of life (EOL) computers.

4. SUMMARY OF THE LITERATURE

The literature shows that the assessment process of used product during reverse logistics is significant research problem as the incident leading to model development could be unique. Therefore, the research emphasizes on developing an integrated model for reverse logistics to remanufacturing in electro-mechanical sector. The model identifies the optimal criteria for acceptance the suitable used product in hierarchical form.

5. RESEARCH METHODOLOGY

To find appropriate companies for being case studies, a background study carried out through collecting data via semi-structured interviews with many companies in electro mechanical sector in Egypt. These interviews were conducted via telephone and emails in order to find out which of those companies are apply reverse logistics system for remanufacturing. The case study is an authorized dealer for Caterpillar as an OEM. Caterpillar is one of the leaders in applying reverse logistics for remanufacturing strategy all over the world. The choice of Case Study Company was made based on the following: Annual remanufacturing volumes; Relation to OEMs; Product complexity and accessibility. The research follows an inductive pattern because the study is based on a transition from specific observation and practical collected data from case study to broader generalizations and ultimately theories.

In the initial investigation, the reverse logistics current system is investigated supported by observation, documentation and interviews with key company personnel. The next section shows the application of credit strategy and the criteria which used by dealers during the assessment process. The work will compare the initial findings of the current system in the case with the proposed model from the literature in order to identify the gaps between the literature and practical application. The gap analysis will be the basis for developing the proposed model. The developed mode will be validated through identifying different scenarios, and running considerable number of experiments using focus group. The research pardiagram is integrated between qualitative and quantitative data in order to establish the model because it is useful to explore a host of factors that may be affecting reverse logistics activities which not addressed obviously in the literature.

6. APPLICATION OF CORE CHARGE/CREDIT PHILOSOPHY

According to Östlin, the customers can receive credits for the type of cores they supply to the company. As a result, this means that the customer can return cores without purchasing a remanufactured product. The amount of credit the customers gain from the supplied cores is dependent on the state of the core, and the credit they have acquired gives them a discount when ordering a new remanufactured product [12].

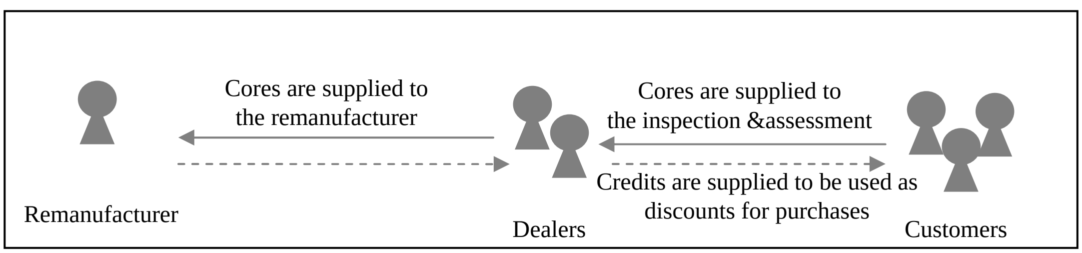

Figure 3: Illustration of the core and credit flow between customer, dealers and remanufacture

Credits are given according to two factors: first, the quality level of the core, and if any of the specific components in the core are missing; second, the amount of credit given, is also variable between different types of products, with cores in higher demand given a higher credit, and lower credit given for cores with lower demand. In this way, the remanufacturer gets a variety of cores and can practice some level of control through the credit system, while the customer can return cores for credit. This type of system enables the remanufacturer to control the balance between the supply and demand. The credit system can also work as a method for assessing the incoming quality level of the cores according to the number of credits given for returned cores. Comparable to, The initial findings of the interviews shows that the case study company applies “core charge/credit” philosophy in order to the following reasons:

- Ensure the timely return of cores fundamental to the successful operation of an exchange program.

- Prevent unplanned discounts which would result if users purchased Remanufactured Products without intending to return an acceptable one.
- Encourage the customer to return the core and buy the remanufactured product.

Cores qualified for exchange credit are those received by the dealers from the sale of corresponding remanufactured products to users. Therefore, the quantity of exchange credits for which a dealer is eligible will not exceed the quantity of corresponding remanufactured products purchased from the company. The types of core credit which are available for dealers are classified to the following:

- Exchange credit: when the core received by the dealer resulted from the sales of a corresponding remanufactured product purchased from the company.
- Direct purchase credit: for a core which resulted from other than a sale of a remanufactured product.
- Warranty credit: for a core resulting from the use of the company remanufactured product in warranty repair.
- Dealer surplus returns: Remanufactured products are returnable to the company on the same basis as new products.

7. CORE ACCEPTANCE CRITERIA GUIDELINES IN ELECTRO-MECHANICAL SECTOR

The core acceptance criteria used by dealer during inspection process to determine if a core is eligible for exchange credit. Table 1 shows the acceptance criteria for camshafts which concluded from the interviews and the documentation provided. Also, the price is evaluated according to level of deposit refund which can be full core deposit refund or damage core refund. For instance, a few product groups, such as camshafts have two levels of possible core deposit refunds. In some circumstances, the core credit will be reduced if major parts are missing or damaged in the core. After inspection, the proper core handling, packaging and labeling are done and the cores are stored until transporting to remanufacturing center.

Table 1 the acceptance criteria and different levels of exchange credit for camshafts (regarding to CAT REMAN Guide TEPs dealer guide and interview with key personal in Mantrac)

level of exchange credit	Camshafts acceptance criteria
Full Core Deposit Refund	– Acceptable part number (company part number only) – Not visibly cracked, chipped, broken, chromed or welded – Lobes not visibly chipped, missing material, or have signs of case crushing. – Journal not visibly spun, chipped, or missing material. – No signs of non-operational damage (mishandling, excessive rust, corrosion, pitting, or evidence of unsuccessful attempts to salvage). – Fully assembled and complete
Damaged Core Refund	– Acceptable part number - Caterpillar part – Lobes not visibly chipped, missing material, or have signs of case crushing. – No signs of non-operational damage (mishandling, excessive rust, corrosion, pitting, or evidence of unsuccessful attempts to salvage). – Fully assembled and complete (assemblies & kits only. see add charges)
No credit	– Unacceptable part number or not a Caterpillar part. – Non-Operational damage (mishandling, excessive rust, corrosion, pitting or evidence of unsuccessful attempts to salvage). – Visibly cracked, broken, chromed, or welded.
Add Charges	– Add charges will be applied for any missing or damaged gear, rocker arm, or lifter

8. Conclusion

The above discussion shows that topics which need to be covered in reverse logistics not only the networking structure and inventory analysis. The collection of used products, their pricing and their suitability to recovery strategy through an establish system are key area for further research.

This paper has illustrated the previous work in the reverse logistics for remanufacturing. The proposed model demonstrated the interaction between reverse logistics activities and remanufacturing processes. Also, the paper explained the application of credit strategy in reality as incentive strategy to return back used product in electro-mechanical sector. Finally, the core acceptance criteria are presented to help dealers and OEMs during core assessment process through conducing case study. In future, an integrated model of reverse logistics for remanufacturing will be developed. The model will identify optimal criteria for acceptance the suitable used product in hierarchical form based on the practical data of different products based on conducting the case study and literature.

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10. References

[1] A. Mutha and S. Pokharel: "Strategic network design for reverse logistics and remanufacturing using new and old product modules", Computers & Industrial Engineering, 2008.

[2] B. A. Beamon and C. Fernandes: "Supply-chain network configuration for product recovery", Production Planning and Control, vol.15, pp. 270–281.

[3] C. Gray and M. Charter: "Remanufacturing and Product Design", The Centre for Sustainable Design, 2007.

[4] C. Prahinski and C. Kocabasoglu: "Empirical research opportunities in reverse supply chains", Omeg , Vol.34, pp. 519-532, 2006.

[5] D. Krumwiede and C. Sheu: "A Model for Reverse Logistics entry by third-party providers", Omega, Vol.30, pp. 325–333, 2002.

[6] D. Lee and M. Dong: "A Heuristic approach to logistics network design for end-of-lease computer products recovery", Transportation Research, Part E 44, pp. 455–474, 2007.

[7] G. Ferrer and C. Whybark: "From Garbage to Goods: Successful Remanufacturing Systems and Skills".

[8] H. Meijer, S. Flapper and C. Clement:"Green Logistics", Handbook of Reverse Logistics, Netherlands, 1998.

[9] H. Dijkhuizen: "Reverse Logistics at IBM", Reverse Logistics, chapter E1310, Kluwer, B.V., Netherlands, 1997.

[10] H. Lourenço and J. Soto: "Reverse Logistics Models and Applications: A Recoverable Production Planning Model", Working Paper # 3, Research Group in Business Logistics, 2000.

[11] H. R. Krikke, A. Van Harten and P. C. Schuur: "Business Case Roteb: Recovery Strategies for Monitors", Computers & Industrial Engineering, Vol. 36, pp.739-757, 1999.

[12] J. Östlin: "On Remanufacturing Systems: Analyzing and Managing Material Flows and Remanufacturing Processes", PhD Dissertation, Linköpings University, Sweden, 2008.

[13] JM. Bloemhof-Ruwaard, M. Fleischmann and J. Van Nunen: "Reviewing Distribution Issues in Reverse Logistics', In: Speranza MG, New Trends in Distribution Logistics, pp. 23–44, Berlin, 1999.

[14] Jr. VDR Guide and LN. Van Wassenhove; "Managing Product Returns for Remanufacturing", Production and Operations Management, Vol.10, pp.142–55, 2001.

[15] Jr. VDR Guide: "Production Planning and Control for Remanufacturing: Industry Practice and Research Needs", Journal of Operations Management, Vol. 18, pp. 467-483, 2000.

[16] K. Kim, I. Song, J. Kim and B. Jeong: "Supply Planning Model for Remanufacturing System in Reverse Logistics Environment", Computers & Industrial Engineering, Vol.51, pp.279–287, 2006.

[17] K. Pochampally, S. Gupt and S. Kamarthi: "Identification of Potential Recovery Facilities for Designing a Reverse Supply Chain Network Using Physical Programming", Proceeding of SPIE, Environmentally Conscious Manufacturing, Vol. 5262, pp. 139–146, 2004.

[18] S. Kara, F. Rugrungruang and H. Kaebernick:"Simulation Modeling of Reverse Logistics Networks", Production Economics, Vol.106, pp. 61–69, 2007.

[19] L.Terrance Pohlen and M. Theodore Farris: "Reverse Logistics in Plastics Recycling", International Journal of Physical Distribution & Logistics Management, Vol.22, pp.35 – 47, 1992.

[20] L. Toktay, L. Wein. And S. Zenios: "Inventory Management of Remanufacturable Products", Management Science, Vol.46, pp.1412–1426, 2000.

[21] De Brito and R. Dekker: "Reverse Logistics- a Framework", Erasmus University, Rotterdam, 2002.

[22] M. Fleischmann, P. Beullens, J. M. Bloemhof-Ruwaard, L. N. van Wassenhove: "The Impact of Product Recovery on Logistics Network Design", Production and Operations Management, Vol.10, pp.156–173, 2001.

[23] M. Fleischmann, H. Krikke, R. Dekker, and S. Flappe: "A characterization of logistics networks for product Recovery", Omega, Vol.28, pp. 653-666, 2000.

[24] M.Fleischmann, J. M. Bloemhof-Ruwaard, R. Dekker, E. Laan, J. Nunen, L. Wassenhove, Klausner and C. Hendrickson: "Quantitative models for reverse logistics: A review", European Journal of Operational Rcsearch Vol.103, pp.1-17, 1997.

[25] M. Thierry, M. Salomon and J. Van Nunen: "Strategic Issues in Product Recovery Management", California Management Review, Vol. 2, pp.114-135, 1995.

[26] O. Listes: "A Generic Stochastic Model for Supply-and-Return Network Design", Computers & Operations Research, Vol. 34, pp. 417–442, 2007.

[27] R. Giuntini and K. Gaudette: "Remanufacturing: The Next Great Opportunity for Boosting US Productivity", Business Horizons, 2003.

[28] R. Kusumastuti, R. Piplani, and G. Lim: "An Approach to Design Reverse Logistics Networks for Product Recovery", In Proceedings of IEEE International Engineering, Management Conference, Singapore, pp. 1239–1243.

[29] R. Lund and W. Denny: "Opportunities and Implications of Extending Product Life", Sump on Product Durability and Life, Gaithersburg, pp.1-11, 1977.

[30] R. Wojanowski, V. Verter and T. Boyaci: "Retail-Collection Network Design under Deposit-Refund", Computers and Operations Research, Vol.34, pp.324–345, 2007.

[31] RC. Savaskan, S. Bhattacharya and LN. Van Wassenhove: "Closed Loop Supply Chain Models with Product Remanufacturing", Management Science, Vol. 50, pp.239–52, 2004.

[32] Rogers, Dale, Tibben-Lembke and Ronald: "Reverse Logistics: Stategies ET Techniques ", Logistique & Management, Vol.7, pp. 15-26, 1999.

[33] S. Mitra: 'Revenue Management for Remanufactured Products", Omega, Vol.35, pp. 553 – 562, 2007.

[34] S. Dowlatshahi: "Developing a Theory of Reverse Logistics", Interfaces, Vol.30, pp.143-155, 2000.

[35] S. Mondal and K. Mukherjee: "An Empirical Investigation on the Feasibility of Remanufacturing Activities in the Indian Economy", Int. J. Business Environment, Vol. 1, No. 1, 2006.

[36] S. Srivastava: "Network Design for Reverse Logistics", Omega, Vol.36, pp. 535 – 548, 2008.

[37] V. Jayaraman, R. Patterson, E. Rolland: "The Design of Reverse Distribution Networks: Models and Solution Procedures', European Journal of Operational Research, Vol.150, pp.128–149, 2003.

[38] V. Jayaraman, VDR. Guide, R. Srivastava: "A Closed-Loop Logistics Model for Remanufacturing", Journal of the Operational Research Society, Vol.50, pp.497–508, 1999.

[39] V. Ravi, R. Shankar, M. K. Tiwari: "Analyzing Alternatives in Reverse Logistics for End-of-Life Computers: ANP and Balanced Scorecard Approach", Computers and Industrial Engineering, Vol. 48, pp.327–356, 2005.

[40] W. Ijomah: "A Model-based Definition of the Generic Remanufacturing Business Process", PhD Dissertation, the University of Plymouth, UK, 2002.

[41] W. L. Ijomah, J. P. Bennett and J. Pearce: "Remanufacturing: Evidence of Environmental Business Practice in the UK", University of Plynouth, 1999.

[42] Z. Lu, N. Bostel:"A Facility Location Model for Logistics Systems Including Reverse Flows: The Case of Remanufacturing Activities", Computers & Operations Research, Vol.34, pp.299–323, 2007.