Chapter-3

Empirical Study
3. Empirical Study

3.1 Introduction

Automobile remanufacturing has been practiced world-wide since long back and various companies are profitably engaged in this venture. But it is still in nascent stage in India though it has tremendous potential for its growth. This chapter deals with seeking the answer to the first research objective as mentioned in section 1.5.

- To explore the important issues which prevent corporate houses of automobile sector from carrying out remanufacturing business in India

This research objective is addressed using a survey method. The survey has been conducted among the Indian automobile manufacturers and their ancillary suppliers to find out the factors which are considered critical for initiating the feasibility of automobile remanufacturing in India. A survey instrument is designed as shown in Annexure I. The questionnaire incorporated all the issues which have been discussed in Chapter-2.

This chapter consists of four sections. In second section, various issues relevant to automobile remanufacturing have been identified on the basis of literature survey done in previous chapter. Section third deals with the development of survey instrument. Finally, section fourth ends with the profile of sample and population under study.

3.2 Identification of issues relevant to automobile remanufacturing

This section deals with the identification of issues that are considered in automobile remanufacturing as per the published literature in chapter-2. The whole set of issues related to automobile remanufacturing is classified into seven classes as; economic issues, environmental policies, marketing issues, acquisition & reverse logistics, inventory management, production planning & control, and design issues. These identified issues are considered as a basis for constructing the survey instrument (questionnaire) for the empirical investigation.
I. Economic issues

The economic benefits from the remanufacturing activities are the one of the prime driver which motivates many companies in US and UK to take it as a profitable venture along with manufacturing business. The profitability from remanufacturing in automobile sector is highest as compared to other sectors. The automobile remanufacturing accounts for two-third of total remanufacturing activities worldwide (Steinhilper et al., 2001). According to Automotive Parts Remanufacturers Association (APRA), the remanufactured auto parts market is estimated at $85-100 billion worldwide. In US, the automobile parts remanufacturing is worth around $34 billion. There are around 150 engine remanufacturers and 1000 automotive parts remanufacturers in US alone. One such example is Caterpillar who remanufactures engine for Ford’s Truck. Its annual revenue generation is over $ 1 billion (Gray et al., 2006). The remanufactured products are comparatively cheaper than new one (Amezquita et al., 1995) in lesser developed market. The economic feasibility of remanufactured product depends upon three factors namely; i) Infrastructure of reverse logistics network, ii) The market for remanufactured products, and iii) The design of the product (Ferrer et al., 2003).

The basic raw material for remanufacturing operation is used product/return/cores. The uncertainty (timing, quantity and quality) involved in the acquisition process complicates the planning and design of reverse logistics which indirectly makes the production process very complex. Hence, an efficient network design is essential for location, collection and transportation of cores to the remanufacturing plant. Beside this, there are many other issues involved in the acquisition and reverse logistics which indirectly contribute to the profitability. These are mode of parts collection, handling and packaging of parts, and non-homogeneity in shape and size of collected parts. In this regard, the contribution by Hammond et al., (1998), is very significant. Various economic and non-economic incentive methods can be also adopted to stimulate the acquisition and reverse logistics activities. Thus acquisition and reverse logistics activities should be given prime importance before the starting-off the remanufacturing business. The second important factor as considered by Ferrer et al. (2003) is the market for the remanufactured products. The customer’s attitude towards remanufactured product is pretty flimsy. They perceive the difference in quality of
remanufactured product on the basis of cost. The work by Steinhilper et al. (2006) is very significant towards the customer’s attitude about remanufactured products. This results in the loss of sale of remanufactured products. Hence, for successful remanufacturing the existence of proper market and demand management is an essential requirement. The third important factor considered important (Ferrer et al., 2003) for economic feasibility of remanufactured product is the design of the product. The design of the product for remanufacturing is a crucial factor that needs to be considered. In other words, the design of the product should be so flexible that it can be easily assembled/disassembled on numerous occasions. Additionally, the parts fragility should be least while transporting and disassembling of the parts. In this regard, the work on design for disassembly (DFD) and design for remanufacturing are in progress to make the remanufacturing operations technically feasible. The work by Gungor et al. (2006) on design for disassembly is very significant in this area. Many issues regarding automobile parts design which is considered highly important for remanufacturing operations are considered by Hammond et al. (1998) in his survey report. Thus the design issues are one of the important factors to be considered while doing economic feasibility analysis of automobile remanufacturing business.

II. Governmental policies

In western countries, the laws regarding environment protection and land-fill are very stringent. These laws indirectly act as a driver for the remanufacturing process. The various laws and policies which are prevalent worldwide especially in western countries basically include; Waste from Electrical and Electronics equipment (WEEE), Take-back programs on reuse of products, The End-of-Life vehicles (ELV) directives, Extended producer responsibility (EPR) law and Restriction of hazardous waste substances (RoHS) directives. In India, the laws which are prevalent include; The Environment (Protection) Rules, 1986 and The Batteries (Management and Handling) Rules, 2001. Many researches are published on environmental issues which target the remanufacturing activities, especially in western countries like, US, UK, Germany, Netherlands and France. In this context, the work by Doppelt et al. (2001) is phenomenal. He studied the impact of environmental legislation on remanufacturing activities. Thiery et al. (1995) and Gungor et al. (1999) contributed towards the environmental issues considered important while initiating remanufacturing activities.
Almost all the automobile companies in US, UK, Germany, Italy, and France follow these environmental norms. For example, Chrysler, Ford, BMW, Volvo, Perkin Engine and Caterpillar. Hence, the role of environmental factors and government legislation are considered very important while taking-up the feasibility of automobile remanufacturing as a business venture.

III. Marketing factors

The marketing factors related to remanufacturing process basically include the market related issues and customer’s attitude towards the remanufactured product. Under marketing issues, the main challenge exists in finding the market for the remanufactured product. As the customer’s attitude towards remanufactured product (Steinhilper et al., 2006) is not mature, the manufacturer is very skeptical to initiate the remanufacturing business. Besides that, the remanufacturing in automobile sector is highly capital intensive which makes this business very critical. In countries like US and UK there exists an organized market for remanufactured product from where the demand could be fulfilled. But in India the existence of spare parts market is pretty disorganized. From these outlets the demand for spare parts are fulfilled with very little or without any consideration on quality aspect of the product. These issues considered as one of the prime hindrance for auto parts remanufacturing in the perception of OEM. Besides that, the chances of existence of market competition for remanufactured product also exist between different players (Majumdar et al., 2001). Smaller firms are considered as the main players in the second-hand market as they are with regard to acquisition related activities, not concerned about product reliability. The fact that they are indifferent towards the price of the product is another contributing factor. Hence, the importance of marketing factors is very crucial for considering remanufacturing operation.

IV. Acquisition and reverse logistics

The importance of acquisition management issues in remanufacturing is distinctive. Its uniqueness lies due to the uncertainty in the acquisition of returns (Guide et al., 1999). These uncertainties span three areas namely, uncertainty in the timing of returns, uncertainty in the quantity of returns and uncertainty in the quality of returns.
The depth and width of the uncertainty makes the process of remanufacturing very complex. These complexities lie in the location of customer base for procuring the returns and managing the transportation of returns from the customer to the remanufacturing plant. The management of reverse flow of used product requires a composite network design. The decision regarding the management of returns depends upon the degree of return rate. If the rate of return is high, companies will manage the acquisition process by itself otherwise, they will outsource it to some external agencies (Third Party Logistics Provider). The selection of external agencies is again a tedious task. It is done by considering various operational parameters like cost, quality, timing, and flexibility of the service (Meade et al., 2002). The automobile sector is a very good example in this context. The rate as well as the quality of return is very high in automobile parts. The cost related to acquisition of returns is uncertain and difficult to control due to uncertainty involved in the quality and quantity of the used products (Savaskan et al., 2004). These sub-factors together make the process of reverse network design very critical (Fleishmann et al., 1997, Johnson., 1998, Srivastava et al., 2008). The complication involved in the management of reverse logistics basically lies in balancing the demand of remanufactured product with supply of returns (used products). Moreover, establishing the linkage between forward and reverse flows of the products is very critical.

V. Inventory management

Inventory management issues in remanufacturing process comprises of wide-range of new challenges in the areas of material requirement planning (MRP), PUSH-PULL strategies, lot-sizing strategies, and maintenance of safety stock. These difficulties arise basically due to the uncertainties involved in the acquisition process. Due to these uncertainties there arises the problem in integration of returns flow which ultimately complicates the producer’s MRP system. Furthermore, it leads to create imbalance between supply (returns/used product) and demand of remanufactured product (Dekker et al., 2000; Inderfurth et al., 2004). Thus, an effective inventory control mechanism is required which can create the balance between the demand and supply (Guide et al., 2000). In this regard, reverse MRP is required which can effectively control the stochastic and hybrid nature of supply of returns (Inderfurth et
In traditional inventory control system, it is quite easy to maintain the correlation between demands and supply of product either applying PUSH or PULL strategies. But, in case of remanufacturing hybrid strategies are applied due to uncertainties involved (Van der Laan et al., 2005). In case of automobile parts recovery, the rate of return as well as the depth of disassembly operation is very high which results in complexity in maintenance of proper lot-sizing and necessary safety stock during production (Minner et al., 2001; Golany et al., 2001). The complexity in the inventory control process makes the OEM outsources these activities to a third party, who can easily maintain this operation due to their local presence and simple management. These third party agencies easily locate the source of returns and maintain the inventory of parts traditionally. Hence, the issue of inventory control plays a vital role while initiating the remanufacturing process in automobile sector.

VI. Design issues

The design issues in context of remanufacturing literally cover the area of product and process (business model) design which enables the remanufacturing process (Sundin et al., 2004). The product design should be such that it can be used numbers of times as an original product or parts for remanufactured product. These characteristics are coined under a particular name i.e., design for remanufacturing (DFR) (Ishii et al., 1995; Gungor et al., 1999). Detailed product design for remanufacture consists of an interrelated group of design strategies, which ultimately build the strategies for eco-design to capture the commercial opportunities of multiple lives and upgrading. These basically include design for core collection, design for disassembly, design for multiple-life cycle, and design for upgrade and evaluation (Gray et al., 1996). The various design issues which probably guide the automobile remanufacturing are effectively studied by Hammond et al. (1998). At present there is little design for remanufacturing is being practiced worldwide. Those who remanufacture are primarily small organizations that have no control over design phase. The importance of design on remanufacturing is not even fully understood by the OEMs. Some companies like Xerox and Caterpillar are controlling both design and remanufacturing operations as well. Hence, the issue related to design plays a vital role while initiating the remanufacturing process in automobile sector.
VII. Production planning & control

The production process of remanufacturing starts with the disassembly operation. Disassembly is defined as a systematic method of disintegrating a product into its constituent parts, components and subassemblies. The planning for disassembly is very complex due to the nature of additive material used as fastener in the original component. The disassembly process to be adopted for separation could be either destructive or non-destructive in nature. In destructive disassembly, the parts will be disassembled into component level by the application of force which results in breaking of some obsolete units. In contrary, in non-destructive disassembly entire unit will be separated into component level without any breakage of any of the unit. In remanufacturing, the decision for performing complete or partial disassembly is very challenging. In complete disassembly, the used product is fully disassembled, where as in partial disassembly, only certain parts or assemblies are recovered (Lambert et al., 2002). These uncertainties in disassembly operation lead to uncontrolled release of parts which may cause long queues at machine centers. This situation may increase lead time and their variability in processing the parts which may affects the customer service cycle level (Guide et al., 1996). Therefore, various types of order-release strategies are to be adopted like level strategy, batch strategy, and local order strategies etc. The process of capacity planning for remanufacturing is very difficult due to existence of uncertainty in rate of core recovery which imbalances the demand and supply processes. Moreover, the traditional MRP system of manufacturing is not applicable in this environment as the rate of return is very unpredictable in nature. In this regard, the work by Ferrer et al. (2001) is remarkable. He tried to establish the correlation between the volumes of used products with the volume of sales. Some new approaches like, Reverse MRP system is applicable in this area where uncertainty will be taken into the consideration while establishing correlation between demand of remanufactured product with that of supply of used products. The production planning and control factor are considered to be very crucial while performing remanufacturing operations. In case of automobile parts remanufacturing, the rate of recovery is very high and the companies are interested in focusing on the main operation to take lead in the market and become niche in that particular segment. Companies like, caterpillar (Globally), Jasper Engines and Transmissions (US), Andre Niermann (Germany), Marshal Engines (US). Hence
the issues related to production planning and control is considered very important for performing feasibility of automobile remanufacturing.

3.3 Development of survey instrument

From the literature survey, we were able to identify 77 issues from various categories as identified in section 3.2 i.e., economic issues (ECO), governmental policies (GOVT), acquisition & reverse logistics (RL), inventory management (INV), production planning & control (PPC), design issues (DESIGN) and marketing issues (MARKET). These 77 identified issues are used for developing the survey instrument. A total of 77 closed-ended questions were framed where the respondents were asked to rate each of the questions in a 5-point Likert scale (as shown below), based on their importance of their criticality while initiating automobile remanufacturing business.

<table>
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<tr>
<th>Scale Rating</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Least Important</td>
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<tr>
<td>2</td>
<td>Somewhat Important</td>
</tr>
<tr>
<td>3</td>
<td>Important</td>
</tr>
<tr>
<td>4</td>
<td>Very Important</td>
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<tr>
<td>5</td>
<td>Most Important</td>
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Further, two open-ended questions were asked to the respondents relating to prospective business units who can initiate remanufacturing business in future and the type of automobile product which can be remanufactured in the current scenario in India.

3.4 Population and sample profile

A list of Indian automobile companies including automotive component suppliers was prepared using the help of various sources like capital line data base (2009), automobile directory (2010) and automobile companies’ websites. A total of 436 companies were listed on overall. The list includes both OEM and Suppliers. Further, OEMs consists of Cars, LCVs, HCVs and Two wheeler manufacturers. Once the population has been decided the sample size was calculated by simple random sampling technique. At 95% confidence interval and allowing 5% level of precision in the estimates we got a maximum sample size of 204. Thus, 204 companies were finally
selected randomly from the population and then questionnaires were sent to them by emails. Repeated reminders were also sent subsequently. Only 16 companies responded by email. Then personal visits to the companies were organized throughout the country. Personal interviews were conducted among various company representatives up to the supervisor level. Some of the companies responded through post.

A total of 72 responses were obtained which forms the sample size of the present study. The sample comprises of 33 OEMs (Original Equipment Manufacturers) and 39 Suppliers. The descriptive statistics of the 77 issues were computed and one sample t-statistics values were calculated from the data for testing whether an issue is considered significantly important or not, i.e., the mean value being greater than or equal to 3 and subsequently for mean value being greater than equal to 4. Further, the analysis was carried out among different class of automobile manufacturers namely, Cars, HCVs (Heavy commercial vehicles), LCVs (Light commercial vehicles), and Two-wheeler manufacturers or OEMs & suppliers and the t-statistics values were calculated to test the issues as well as factors considered significantly important for initiating remanufacturing business in India.

<table>
<thead>
<tr>
<th>Table 3. The population and sample description</th>
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<tr>
<td><strong>Automobile companies type</strong></td>
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<tr>
<td><strong>Classification</strong></td>
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<tr>
<td><strong>Number</strong></td>
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<td><strong>Total number</strong></td>
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<td><strong>Sample size</strong></td>
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<td><strong>Population size</strong></td>
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In the next chapter, the analysis of the data collected from the 72 respondents is carried out.