

## EXPLORING THE POTENTIAL OF REMANUFACTURING IN INDIAN INDUSTRIES FOR SUSTAINABILITY AND ECONOMIC GROWTH

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### ABSTRACT

This research work explores the potential for utilization of Remanufactured products in the Indian context. Business in the remanufacturing sector, dealing with products such as computers, cartridges, machinery and mobile phones all over the world, indicate significant potential for similar opportunities elsewhere. Indian markets, though in an infancy stage, too have a huge potential for remanufactured products. According to the Automotive Parts Remanufacturers Association, the Indian regulatory authorities should move rapidly to change their position in trade of the remanufactured products as well as promote the creation and expansion of a remanufacturing industry in their country. In this paper, a case study is analyzed and information from different manufacturing industries involved in remanufacturing was collected through a questionnaire from middle and top-level management authorities of various manufacturing firms. The statistical analyses of data and findings are complemented by similar views and approaches related to remanufacturing expressed by professional bodies such as APRA, ASSOCHAM and ICRRRA. The analysis of case study of Indian Railways has proved that the cost incurred in remanufacturing is less as compared to new products. Correlation between Product Cannibalization and Willingness To Pay (WTP), as well as with Price of remanufactured product and Quality were analyzed to establish concrete results with regard to the Cannibalization issue. This paper fulfils the need to explore and study the remanufacturing sector and its related issues in detail in India. Economic aspects and environmental concerns, especially in the context of sustainable development also support and promote the idea of utilization of remanufactured products.

**KEYWORDS:** Remanufacturing, Product Cannibalization, End-of-Life Product, Willingness to Pay, Sustainability, Economic Growth, Product Life Cycle

### INTRODUCTION

Material recovery from End-of-Life (EOL) products is a key issue in sustainable product development and research to explore this aspect is gaining importance today. Among the various material recovery processes, remanufacturing is gaining importance as one of the profitable alternatives. Remanufacturing is the process, where in an EOL product is collected from a customer and a series of remanufacturing operations carried out so as to achieve the quality of products as good as that of a new product. Customers are attracted towards remanufacturing due to satisfactory quality level and low price as compared to new products ((Debo *et al.*, 2005; Ferguson, 2009; ASR, 2012; Vasudevan *et al.*, 2012). During the last few decades, awareness about the need for environment protection has also grown largely. Continuous changes, related to this aspect, are happening today for better with even pressure from legislation & environmental awareness among consumers. Currently, the industry sector that has the most experience in the remanufacturing area is the automotive industry. However, the concept of remanufacturing has become popular in the

recent decades due to huge demand of remanufactured products like computers, cartridges, household appliances, machinery and mobile phones (Guide, 2000; Östlin *et al.*, 2009; Hauser and Lund, 2008).

Perfect Launching of a remanufactured product is necessary for deriving maximum share in the market place (Terkar *et al.*, 2011). Demand of a remanufactured product also depends upon the product life cycle of an existing product. Predicting the demand of a remanufactured product and its perfect launching is not an easy task for a company (Östlin *et al.*, 2009; Jun-yu, and Zhao, 2010). Study of disposal rate of existing product is also another crucial issue for remanufacturing industries (Hermansson and Sundin, 2005; Seitz and Peattie, 2004; Terkar *et al.*, 2012). It is also interesting to study the issue of product cannibalization due to entry of remanufactured products in India (Vasudevan *et al.*, 2011).

## **REMANUFACTURING SECTOR IN INDIA**

In India, cartridge products have been accounting for major share in the remanufacturing sector and still customers are not fully aware of the benefits obtained from remanufacturing. Market for remanufactured automotive products has not grown up much in India. Top Bearing manufacturing companies like Timken India Pvt. Ltd. gives remanufacturing as a repair service option to customers. However, remanufactured automotive products are yet not available in the automobile shops in India (Terkar *et al.*, 2012, Terkar *et al.*, 2013). Why have the Indian Industries not moved for remanufactured automotive products? Why is the automotive sector not growing in its business of remanufacturing in India? These issues are important and need a thorough investigation. It is also widely known that the consumption of natural resources is at an increasing rate today, even as consumer demands for material from the crust of the earth are constantly increasing. In this context, it is imperative to start thinking of how to utilize all these resources more effectively for sustainable product development and cost effective manufacturing. Remanufacturing is also seen as a sizzling business prospect worldwide and the business of e-waste is the most beneficial and also very successful (Atasu *et al.*, 2008; Seaver, 1994).

According to Indian Cartridge Remanufacturers & Recyclers Association (ICRRA), in the case of laser toners sold, only less than 10 percent are remanufactured and recycled and out of these, only 20 percent cartridges are remanufactured in India. Cartridge making firms in India have largely been into refilling than remanufacturing (Jalihal, 2009). The cost is a key deciding factor, as people are unwilling to pay 75 percent of the price of the product of the Original Equipment Manufacturer (OEM). Static Control Components (SCC) has also formulated aggressive tactics for India. The company produces around 13,000 different parts including drums, ink, casings and chips for 1,200 different toners and cartridges (Swartz, 2011). According to International Director Sales of India: SCC, Stuart Lacey, the Indian market has very tough conditions and is under developed and yet has enormous potential and this market will be very important in the future with firms investing a lot of time, energy and money into it.

### **Views of Regulatory Authorities in India on Remanufacturing Issues**

The Indian remanufacturing industry continues to play a secondary role and even after more than a decade of its existence, it is yet to categorize itself and chalk out powerful strategies. The secondary role played by the Indian remanufacturing industry is mainly due to the lack of associations and negative end user perceptions. The proposal of free trading of remanufactured products in view of profitability and environmental protection is driven by the USA in the last World Trade Organization (WTO) meeting at Geneva. However, such an important issue did not get any importance during the recently concluded meet. It is very unfortunate that remanufactured goods have not been defined in the Foreign Trade Policy in India. Under Para 2.17 of foreign trade policies, import of remanufactured goods are allowed against the license

(MFDR, 2012). The Article 'Ministerial Decision on Trade in Remanufactured Goods' also shows the lack of awareness of Government authorities about policy making related to remanufactured products (IWTO, 2009). The article clearly demonstrates the approach filled with full of negativity about remanufacturing of products. It may be noted here that India is losing huge assets and employment opportunities due to such approaches of regulatory authorities.

Today, top industries like Caterpillar, GE and Timken etc. are engaged in remanufacturing of products. Automotive parts, cartridges, electronics, medical devices etc. are major industries in this sector, which are trading globally. They have already crossed \$100 billion business in remanufacturing and have formed production facilities in Asia, Africa, Europe and Latin America, in addition to the biggest market, the USA. Developing countries think that the trade of a remanufacturing product means transport of waste from developed countries to them or in other words, it is considered the easy way of shifting of environmental and safety burden from developed countries to developing countries.

India permitted imports of second-hand assets and goods by the end users without requiring an import license but for importing the remanufactured products, import license is necessary from Indian chartered engineers. Whereas, India's official Foreign Trade Policy issued during October 2011 treats remanufactured goods the same as second-hand products and has not made any differentiation among remanufactured, refurbished, reconditioned and second-hand goods (FDB, 2011).

#### **APRA on Remanufacturing Issues in India**

The Automotive Parts Remanufacturers Associations (APRA) is one of the top associations working for automotive remanufacturing sectors. Thousands of firms involved in remanufacturing are members of APRA. President of APRA has advised the Indian Government to allow trade in remanufactured products on the same basis as that of new manufactured products (Bill Gager, 2011). APRA president has also stated that the refusal of remanufactured products puts India in the position of supporting anti-environmental policies and not providing cost-effective alternatives for Indian consumers and industries. It is expected that the Indian Government move quickly to change the international import rules on trade in remanufactured products. India, being the second most populated country in the world with 17% of world population, should accept trade in remanufactured products to promote the establishment and growth of a remanufacturing industry. In the event of the Indian government allowing the remanufacturing to happen, near about 5, 00,000 jobs will also be created as in the U.S. market (Gager, 2011).

#### **Efforts of the Associated Chambers of Commerce and Industry of India on Remanufacturing**

The Associated Chambers of Commerce and Industry of India (ASSOCHAM) conducted a national seminar on 'Remanufacturing' in 2009 and concluded certain remarkable points for achieving sustainable growth. ASSOCHAM has stated that the Government of India should allow remanufactured products without import license. Original Equipment Manufacturers (OEMs) have a huge market share in India and only they should be allowed as remanufacturers in the initial stage. Moreover, due to the fear of product cannibalization of new products, many OEMs are not entering into remanufacturing business (Jindal, 2009). Landfills of EOL product are harmful to soil and water degradation and other harmful effects and hence remanufacturing is the true solution to reduce waste for sustainable growth. For consumer, remanufactured products are excellent options because, price of a remanufactured product is usually less by 30 to 35% of new products. According to the definition, remanufactured products have to give the same performance parameters as per the customer expectations with the same warranties as new products have. The Chamber has also suggested that the Indian Government should insist that for each remanufactured product imported, the party should export a corresponding EOL product.

## RESEARCH HYPOTHESES

To address the issue related to remanufacturing of products in the Indian market, some important basic information were collected about the cost saving due to remanufacturing through case studies from Indian remanufacturing industries. From the viewpoint of a Remanufacturer, cost, quality and market demand are the main important factors and from a customer's point of view, quality and price are the motivating factors to buy the remanufactured products. If the cost of a remanufactured product is less than that of a new product with high margin, then it will be a huge motivating factor for remanufacturers (Atasu, *et al.*, 2010; Lund and Hauser, 2009, Terkar *et al.*, 2013). In this research work, a case study is also conducted in order to find the cost saving percentage of remanufactured products over new ones. Willingness To Pay (WTP) on the part of customer, expectation of quality of a remanufactured product and product cannibalization issues were examined as also based on a questionnaire. WTP towards the remanufactured product as well as new product is an important factor to be studied. Many customers are more conscious about the quality and hence they are willing to purchase only new products (Sarvary and Wassenhove, 2009; Terkar *et al.*, 2011). Quality of a remanufactured product and customers' WTP are important elements in the market and correlation between these two is necessary to be explored. If the customers are feeling that, the quality of remanufactured product is really the same as that of new one, then WTP is increased towards remanufactured products. Hence, we need to look at whether there is any correlation between WTP and Satisfaction or Quality.

Product cannibalization is a big issue in the markets and it is necessary to ascertain certain facts about it. It is also important to note as to why the OEMs in India have a fear of the cannibalization due to remanufactured products? WTP towards a remanufactured and a new product is therefore an important factor while considering the issue (Guide and Li., 2010). The correlation between WTP and the product cannibalization issue is also very important. In Indian market, many OEMs have a fear of cannibalization of their new product due to entry of a remanufactured version. Demand of a remanufactured product totally depends upon the rate of change of technology. Due to change of technology, demand of old technology products decreases continuously and hence remanufactured version of such a product is also not in much demand. Categorization of products into time-sensitive and time-insensitive products is essential to predict the market demand (Ostlin *et al.*, 2009; Sasikumar & Kannan, 2008; Terkar *et al.*, 2012). In computer and mobile instruments sectors, products are time-sensitive due to rapid change in technology and hence, the prediction of market demand is not easy in such sectors (Vasudevan *et al.*, 2012). Time-insensitive products are useful to be considered in remanufacturing and many customers are taking these advantages in automotive manufacturing sectors (Matsumoto & Umeda, 2011). Cartridge products are also time-sensitive products and yet they are very popular in the remanufacturing sector due to the short life of product (Terkar *et al.*, 2013). Customers are always attracted towards new technology upgraded products; hence, the new products have their own strong customer segments.

Based on literature review, the following hypotheses have been formulated to analyse the above-mentioned issues.

*H<sub>01</sub>: Cost incurred for a remanufactured product is less than the cost incurred for a new counterpart product.*

*H<sub>02</sub>: Existence of a remanufactured product will cannibalize the sale of its new counterpart product.*

*H<sub>03</sub>: Product Cannibalization of a new product due to the sale of counterpart remanufactured product and customers' willingness to pay are related to each other.*

*H<sub>04</sub>: Product Cannibalization of a new product due to the sale of counterpart remanufactured product and price saved due to remanufactured product are related to each other.*

*H<sub>05</sub>: Product Cannibalization of a new product due to the sale of counterpart remanufactured product and quality of remanufactured product are related to each other.*

## **METHODOLOGY**

Remanufacturing is not an organized industrial sector in India; hence, it was difficult to gather the data for conducting such a research study. Except for remanufactured cartridges, other remanufactured products are rarely available in the market. In the survey, it was found that most of the people in India do not have much awareness about remanufactured products. Most of the quality conscious customers are not yet ready to accept the remanufactured products. After vigorous literature survey, the questionnaire was formulated into four parts. Question items included in the questionnaire are close ended for getting a specific answer in a short time. Experts required about 05 to 10 minutes to answer the online questionnaire and a total of 26 questions are included in the questionnaire. In India, remanufacturing is still at an infancy stage and very few industries are available in automotive remanufacturing sector. Hence the Automotive Parts of Remanufacturers Associations (APRA) was chosen to get the answers to the questionnaire through their members. A total of 4662 remanufacturing industries were addressed to through APRA, who are remanufacturers of different automotive products. Letters were sent through mail for getting a quicker response. Data were collected from some top and middle management level authorities of remanufacturing businesses through a questionnaire. Most of the questionnaires were filled by the Presidents, Vice presidents, Plant Managers and Production Managers of industries. During the course of this exercise, several important insights for sustainable product development were obtained. 122 responses to the questionnaire were obtained and the analysis of the same is supportive of the case study, which are explained in this paper. Most of the respondent organizations fall under the category of Small to Medium Scale Enterprises (SMEs). Many managers felt that the remanufactured product would cannibalize the new products. Many of them also believed that the willingness to pay towards remanufactured products is very less as compared to new products. From the case study, the cost savings due to remanufacturing and its benefits were obtained. The questionnaire would give a clear picture about the profit percentage in remanufacturing and new products. From the questionnaire, it was tried to find the relation between willingness to pay towards remanufactured products and satisfaction of customers. The parameters found through the questionnaire are supportive of the case study explained in this study.

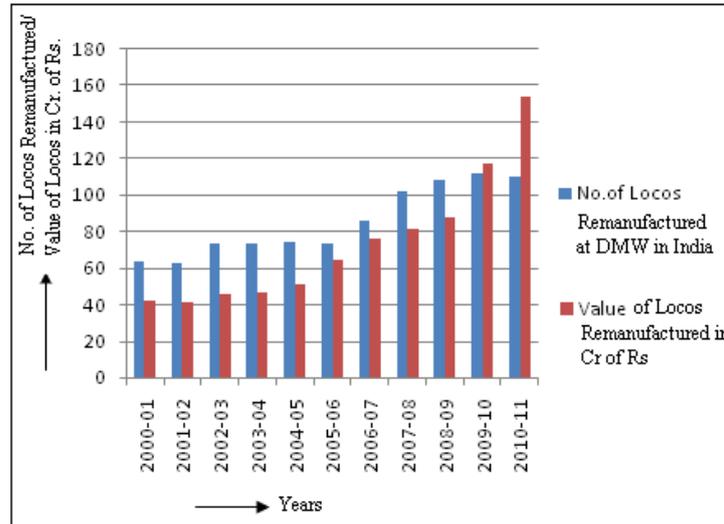
After vigorous literature survey, it was found that many companies in India provide remanufacturing service to their old clients. Large Scale Companies like Timken India collects EOL bearings from their customers and offers remanufactured bearings with fewer prices. Some firms like Indian Railways also remanufacture the locos for sustainable product development with huge capital savings. The case study of Diesel Locomotive Modernisation Works (DMW) is examined to emphasize on the importance of remanufacturing sector in India and to understand remanufacturing benefits to producers as well as customers.

## **REMANUFACTURING AT DMW**

Indian Railways started Diesel Loco Modernization Works (DMW) at district Patiala, India in 1981. Due to huge amount of EOL products, DMW started the remanufacturing of those EOL parts in 1989. Spare parts like Microprocessor Control System, AC-DC power transmission, Fuel Efficient Engine Kits, Roller Bearing Suspension System, Traction Motors, Crankshaft, revolving chair, fan and large size sliding windows are remanufactured every year (See figure 1). Thousands of parts are remanufactured by DMW, which saves a huge amount of energy, material and capital cost. This case study evaluated the need of remanufactured locos and its benefits in India. If the Indian railways are doing well in the remanufacturing sector and Government is getting huge benefits, then the question arises as to why Government

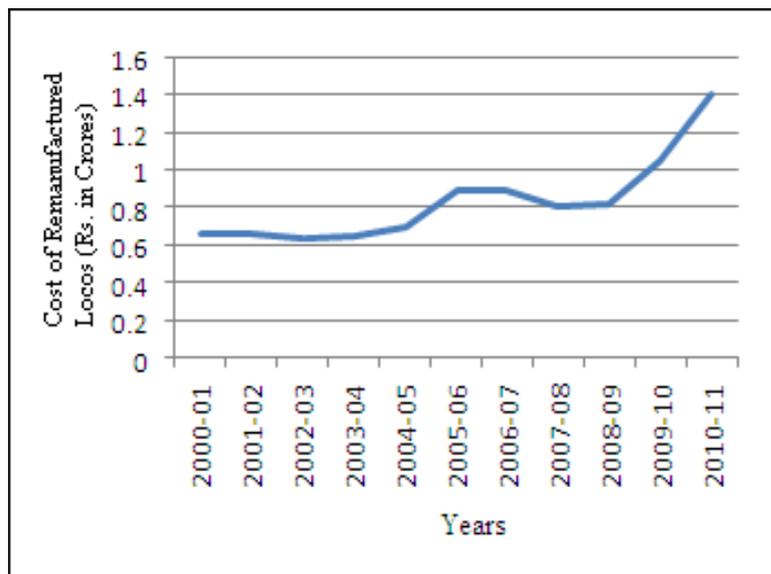
policies are not supportive to remanufacturing import policies. This case study is also useful as a guide to many industries in India to understand the importance of production of remanufactured goods for green growth and sustainability.

**COST ASSOCIATED WITH REMANUFACTURED LOCOS**



**Figure 1: Values of Locos Remanufactured**

Details of remanufacturing data from the year 2000 to 2011 have been shown in fig.1. In the year 2000-01, 64 locos had been remanufactured and cost associated during this year was Rs. 41.8 Crores. Remanufacturing cost per locos was around Rs. 0.6531 Crores in 2000-01 and this cost was a little bit steady between the years 2000 to 2005. Cost of a remanufactured locos was seen increasing from 2006 to 2011 and finally it moved up to Rs. 1.4 Crores (see the figure 2).



**Figure 2: Cost of Remanufactured Locos per Unit**

Table 1 shows the annual growth in percentage for remanufactured locos from the year 2000 to 2011. The number of Remanufactured locos has been increasing consistently and finally it has reached upto around 110 locos. Future demands of remanufactured locos are seen increasing and in the coming years, it is expected to cross 200. Hence, the DMW has to make a plan according to the future demand. In 2007-08, growth percentage of remanufactured locos was seen increasing up to 18.6 and in 2011 the growth was a little bit negative.

**Table 1: Annual Growth in Percentage**

Year	No. of Locos Remanufactured	Annual Growth in %
2000-01	64	NA
2001-02	63	-1.15
2002-03	73	15.76
2003-04	73	0
2004-05	74	1.15
2005-06	73	-1.15
2006-07	86	17.8
2007-08	102	18.6
2008-09	108	5.88
2009-10	112	3.7
2010-11	110	-1.7

Remanufactured locos are giving constantly good results on the field and Indian Railways are saving a huge amount of energy, material and capital investment for green growth and sustainability.

### **COST SAVING DUE TO REMANUFACTURED LOCOS**

Table 2 explains about the cost of a new unit and cost of a remanufactured unit. Traction Motor Magnet Frame and Converted Magnet Frame require Rs. 0.015 in Crores for new units but for remanufactured operation, the cost required is 67 % less than the cost required for new one. Engine block also required Rs. 0.15 in crores for a new unit, but the remanufacturing operation saves around 70 % cost. Parts like Loco under Frame Weight, Bogie Frame Weight saves 90 % of costs due to remanufacturing operation and this is a remarkable saving in cost. From 2000 to 2011, total locos remanufactured are 938 and the total cost required for remanufactured operation is 807.42 crores.

**Table 2: Cost Saving Due to Remanufacturing in %**

Description	Weight in tons	Cost of New Unit (Rs. in Crores)	Cost of Remanufactured Units (Rs. in Crores)	Cost Saving due to Remanufacturing in %
Engine Block	5.5	0.15	0.045	70
Traction Motor Magnet Frame	1.25	0.015	0.005	67
Converted Magnet Frame	1.25	0.015	0.005	67
Loco under Frame Weight	20	0.200	0.020	90
Bogie Frame Weight	3.5	0.050	0.005	90

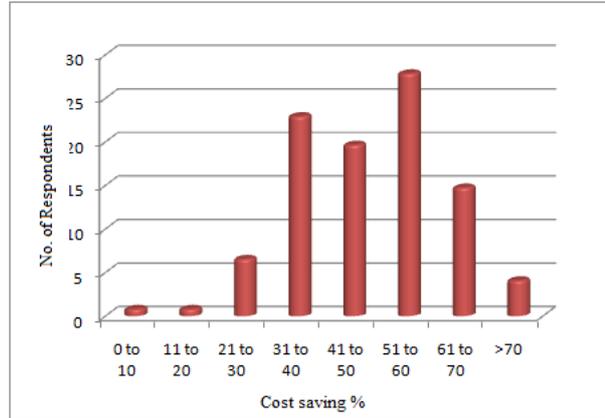
From table 2, it is clear that the average cost saved due to remanufacturing is around 75 % of new product. Due to remanufacturing, DMW saved around Rs. 2422 Crores from the year 2000 to 2011. This cost saving due to remanufacturing plays an important role in the Indian Railway Industry and this is also considered a very important step towards green growth and sustainability. Therefore the null hypothesis formulated  $H_{01}$ : **Cost incurred for a remanufactured product is less than cost incurred for a new counterpart product** has been accepted.

### **COST SAVING PERCENTAGE DUE TO REMANUFACTURING**

Cost saving percentage due to remanufacturing is explained in fig 3. Total 122 respondents from the industries have replied to this research question. 27.28 % of respondents said that the cost saving due to remanufacturing is around 51% to 60% of a new counterpart product. 88.47 % respondents felt that the cost saving due to remanufacturing is in between 31% to 70%.

Based on the questionnaire and case study, it can be concluded that the cost required for a remanufactured product

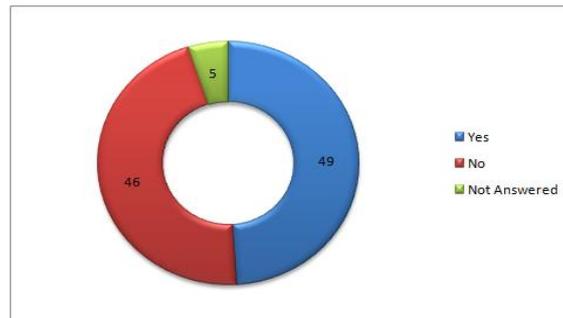
is less as compared to new products and cost saving is the predominant factor in business and hence the hypothesis  $H_{01}$  : **Cost incurred for a remanufactured product is less than cost incurred for a new counterpart product** has been accepted.



**Figure 3: Cost Saving Due to Remanufacturing**

**EXPERTS OPINION ABOUT PRODUCT CANNIBALIZATION**

Expert’s opinion about product cannibalization due to a remanufactured product is necessary to be explored. From the literature also, it can be seen that many authors have written that the most of companies are thinking that the sale of a remanufactured product would cannibalize the sale of a new product. When the survey was conducted through the questionnaire, similar types of results were obtained.



**Figure 4: Product Cannibalization in View of Experts**

Figure 4 shows that 49 % experts from remanufacturing industries are of the opinion that the remanufactured product would cannibalize the sale of new product and 46% experts are of the opinion that the remanufactured product does not cannibalize the product. It can also be seen from the above figure 4, that the support to **hypothesis  $H_{02}$ , is justified**. To conclusively prove this issue, some more hypotheses support is necessary to be explored, and hence next few hypotheses are on Product cannibalization and its correlation with quality, WTP and Price saved due remanufacturing. 05 % experts did not reply to this question and margin between ‘Yes and No’ is very thin, hence next three hypotheses are considered important to address this issue.

**PRODUCT CANNIBALIZATION & WTP**

Through the questionnaire, it was seen that many respondents are of the opinion that the remanufactured product cannibalizes the sale of new product. It is necessary to study the correlation between willingness to pay towards a remanufactured product and cannibalization due to sale of a remanufactured product. If these two factors show the relation with each other then it supports and accepts the null hypothesis  $H_{02}$ .

**Table 3: Observed Count of Influence between WTP and Product Cannibalization Due to Remanufacturing**

Count for Product Cannibalization	Willingness to Pay towards Remanufactured Product is less than New Product		Grand Total
Product Cannibalization	0	1	
0	22	18	40
1	32	44	76
Total	54	62	116

**Table 4: Expected Count of Influence between WTP and Product Cannibalization Due to Remanufacturing**

Count for Product Cannibalization	Willingness to Pay towards Remanufactured Product is less than New Product		Grand Total
Product Cannibalization	0	1	
0	13.62	21.38	40
1	35.68	40.62	76
Total	44	62	116
Chi Square(x2) =1.7520 ; Degree of freedom (Df) = 1; Probability 'p' = 0.1856 > 0.10			

Table 3 & 4 show the data collected from respondents. Probability ' $p$ ' is greater than 0.10, hence the Chi Square test is not significant and null hypothesis has been rejected. Therefore the hypothesis  $H_{03}$ : **Product Cannibalization of new product due to the sale of counterpart remanufactured product and customer's willingness to pay are related to each other** has been rejected. Product Cannibalization due to a remanufactured product and willingness to pay towards a remanufactured product do not relate to each other.

## PRODUCT CANNIBALIZATION AND PRICE SAVING

Customers get important benefits due to price saving due to remanufacturing, but still the willingness to pay towards a remanufactured product is less as compared to a new product. Mostly, quality conscious customers are willing to buy the new product. It is necessary to check the correlation between product cannibalization and price saving due to remanufacturing. Here, a Chi Square test was conducted to find relation between these two factors. Table 5 and 6 shows observed and expected count for price saving due to remanufacturing and Product Cannibalization.

**Table 5: Observed Count for Price Saving and Product Cannibalization**

Count	Product Cannibalization due to remanufactured Product		Grand Total
Price Saved due to Remanufactured Product	0	1	
0-10	1	0	1
11-20	9	9	18
21-30	19	20	39
31-40	13	17	30
41-50	12	6	18
51-60	1	1	02
61-70	2	2	04
>70	0	4	04
Total	57	59	116

**Table 6: Expected count for Price Saving and Product Cannibalization**

Count	Product Cannibalization due to remanufactured Product		Grand Total
Price Saved due to Remanufactured Product	0	1	
0-10	0.49	0.51	1
11-20	8.84	9.16	18
21-30	19.16	19.84	39
31-40	14.74	15.26	30
41-50	8.52	9.48	18
51-60	0.98	1.02	2
61-70	1.96	2.04	4
>70	1.96	2.04	4
Total	57	59	116
Chi Square (x2) =7.5689 Degree of freedom (Df) = 7 Probability 'p' = 0.3721 > 0.10			

From table 6, it is clear that probability ‘p’ is greater than 0.10 and hence the null hypothesis is rejected. Therefore, the product Cannibalization of a new counterpart product due to sale of remanufactured product and Price saved due to remanufactured product are not related each other. It is important to note this as there is no relation between price saving due to remanufacturing and product cannibalization, hence the hypothesis  $H_{02}$  gets more support towards rejection.

**PRODUCT CANNIBALIZATION DUE TO REMANUFACTURING PRODUCT AND QUALITY**

WTP towards a remanufactured product and price saving due to remanufacturing have not shown impact on the process of cannibalization. Sale of a remanufactured product mostly depends upon quality of a remanufactured product, and this is an important factor in product cannibalization process. Therefore, It was important to check the relation between product cannibalization and quality of a remanufactured product.

**Table 7: Observed Count for Quality and Product Cannibalization**

Count for Quality	Product Cannibalization due to Remanufactured Product		Count of influence
Quality of Remanufactured Product	0	1	
0	8	5	13
1	43	60	103
Total	51	65	116

**Table 8 : Expected Count for Quality and Product Cannibalization**

Count for Quality	Product Cannibalization due to Remanufactured Product		Count of influence
Quality of Remanufactured Product	0	1	
0	5.72	7.29	13.01
1	45.28	57.71	102.99
Total	51	65	116
Chi Square(x2) =1.8338 Degree of freedom (Df) = 1 Probability 'p' = 0.1756 > 0.10			

Table 7 & 8 shows the observed and expected count for Quality and Product Cannibalization due to remanufacturing. On collected counts, the Chi Square test was conducted to get the correlation between these two factors. Hypothesis  $H_{05}$  is that Product Cannibalization of a new product due to sale of counterpart remanufactured product and quality of remanufactured product are related to each other. Value of ‘p’ is greater than 0.10 and hence the test is not significant and therefore the hypothesis  $H_{05}$  has been rejected.

## PRODUCT CANNIBALIZATION

Through the descriptive analysis, it was concluded that about 49 % of respondents say that the remanufacturing cannibalizes the new products and 46% respondents did not feel so. 05% respondents were not in a position to answer on cannibalization issue. Hypothesis  $H_{03}$ ,  $H_{04}$  and  $H_{05}$  are rejected and hence it is clear that product cannibalization due to a remanufactured product over its new counterpart product do not have influence of customers WTP, Price saved due to remanufacturing & quality of remanufactured product. Whereas these parameters play an important role in product cannibalization. Rejection of hypothesis  $H_{03}$ ,  $H_{04}$  and  $H_{05}$  indicates that the remanufactured product does not cannibalize the sale of new product heavily. However, it can be concluded that the product cannibalization does practically occur, though to a negligible extent. Further due to the fact that the cannibalization does not occur in any significant manner, it was required to further test various interactive relationship of cannibalization. There is a possibility of minor cannibalization and this is a major issue all over the world.

## CONCLUSIONS

Indian Deisel Locomotive has been doing a really good work in remanufacturing & it is considered important for green growth and sustainability as it saves a huge amount of material, energy & cost required for production. Many professional bodies like ASSOCHAM, APRA and ICRRA say that the Indian authorities should move rapidly to change their position on trade in remanufactured products to expand the base of remanufacturing industries in the country. Many OEMs in India have the fear of product cannibalization due to the entry of a remanufactured product. In this context, few hypotheses were formulated to explore the customers' attitude towards WTP and the product cannibalization issue. Through the analyses of a questionnaire, the issue of cannibalization due to remanufacturing is found to be acceptable by a slight margin. Further, due to the fact that the cannibalization does not occur in any significant manner,  $H_{03}$ ,  $H_{04}$ , and  $H_{05}$  hypotheses were formulated to sort out this issue, collecting data from practitioners in the industry. Through the hypothesis  $H_{03}$ ,  $H_{04}$ ,  $H_{05}$ , it has been proved that the cannibalization due to sale of a remanufactured product as well as WTP, quality and Price are not shown to be related. Therefore, rejection of hypothesis  $H_{02}$  have a valid reason. However, it can be concluded that the product cannibalization does occur, though to a negligible extent. Moreover, many OEMs still think that the remanufactured product would cannibalize the product. It is also to be noted that through the case study and questionnaire, it was not entirely possible to arrive at an exact conclusion about the same in this study.

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