Remanufacturing Benefits: An Analysis of Recent Trends in Indian Context

Vinay Ahuja, Dr. Ravi Terkar
Mukesh Patel School of Technology Management & Engineering, Mumbai, India
vinayahuja.nmims@gmail.com, ravi.terkar@nmims.edu

Abstract. In the past years, remanufacturing processes have become a popular topic in the industrial area and has become one of the most effective and potential strategies for the “end of life” project management. Material restoration from end of life (EOL) items is the key to most of the remanufacturing processes that have discovered as of now. This paper talks about two case studies – 1. Indian Cartridge Remanufacturers. 2. Remanufacturing at Timken. Remanufactured products are high in demand and its relevance is growing currently due to various factors. This high demand in the market is due to its low price and remarkable functional quality. Remanufacturing is recognized only 10 and a half years back in India and hence hasn’t captured a very high market share compared to scenarios worldwide. Remanufacturing is a $35 Billion industry today and it justifies its cost just as it significantly increases the potential life of components by repair. In this research paper, the research work has studied the remanufacturing operation at Timken India Ltd. As well as their customers like Lafarge Cement, Tinplate Company of India and Usha Martin and has highlighted the advantages of remanufacturing.

Keywords: Remanufacturing Process, Product Cannibalization, Original Equipment Manufacturers, End of life, Indian Cartridge Remanufacturers, Remanufacturing

1. Introduction

Material restoration from end of life (EOL) items or product recovery is a key strategy resulting products being returned to the market in new condition or even better, becoming one of the key issues in green growth and sustainable product development area of research. A product is said to be remanufactured when an EOL item is collected from any customer to restore its value and engineer it to yield a ready to use product again. This has done by carrying out a series of remanufacturing tasks so that the product can be reused or recycled and brought back to the market as good as a new product [1, 2]. Customers are pulled in towards remanufacturing because of attractive quality dimension and low cost when compared with new counterpart products. Amid the most recent couple of decades, awareness about environment protection studied in large extent. At present, the industry part that has the most involvement in the remanufacturing zone is the car business. Be that as it may, the idea of remanufacturing has turned out to be prevalent in the ongoing decades because of tremendous interest of remanufactured items like PCs, cartrigdes, family unit apparatuses, hardware and cell phones. Perfect Launching of a remanufactured item is vital for determining most extreme offer in the commercial center. Demand of remanufactured products relies on the EOL of a current item. Foreseeing the interest of a remanufactured item and its ideal propelling isn’t a simple errand for an organization. Investigation of disposal rate of existing item is likewise another urgent issue for remanufacturing ventures. It is also necessary to study the problem of product cannibalization due to admission of remanufactured products in the market [3]. Remanufacturing ventures do have tremendous turnover in United States, the turnover of the business was assessed at $40.5 billion out of 2003. In the United Kingdom as well, the turnover of the remanufacturing business was evaluated to be £5 billion of every 2004.

2. Problems of Remanufacturing in India

As indicated by Associated Chambers of Commerce and Industry of India (ASSOCHAM), Original Equipment Manufacturers (OEMs) should bolster the remanufacturing businesses in India. Some OEMs do have a dread that the remanufactured product will
eat the market of new product. ASSOCHAM in a report to the Ministry of Commerce and Industry have recommended with the expectation of complimentary exchanging of remanufacturing items in India. The Automotive Parts Remanufacturers Association (APRA) feels that the Indian Government should move quickly to change their situation on exchange remanufactured items and support remanufacturing sector for green growth and product sustainable development. In fact, considering all the benefits, they suggest the OEMs to start their own venture in remanufacturing products. Many OEMs fear product cannibalization due to remanufacturing but this cannibalization can also help them increase their overall profit. As OEMs normally utilize remanufactured items, under contractual understanding for repairs and overhaul of its own products under warranty already in the market place eliminating fears of cannibalization of other products in the market place [4-6].

3. Extent of Remanufacturing in Indian Market

Remanufacturing is a sizzling business prospect worldwide and the matter of e-squander is the most advantageous and accordingly effective result. India is the second most populated nation on the planet and the need of remanufacturing is recognized 10 years and a half back in India. As indicated by driving Indian makers, Indian businesses, however have made a moderate begin, are yet to deal with it and consequently the business is still in its initial life. A lot of study suggests that remanufacturing helps in going green as well has its own economic advantages and this has highly influenced firms in the cartridge manufacturing business. Today remanufacturing is a $35 billion industry, which speak to about 30 percent of the $115 billion worth printer cartridges advertise all around. However, the Indian remanufacturing industry keeps on assuming an optional job and even after over a time of presence, it is yet to classify itself. The optional pretended by the Indian remanufacturing industry is primarily because of absence of affiliations and negative end client suppositions. As indicated by Indian Cartridge Remanufacturers and Recyclers Association (ICRRA), just fewer than 10 percent remanufactured and refilled inkjet cartridges and laser toners were sold and among these, just 20 percent cartridges were remanufactured in India. Cartridge making firms in India has to a great extent been into refilling than remanufacturing. The expense is a key integral factor, as individuals are reluctant to pay 75 percent of the cost of the Original item. Aggressive strategies for remanufacturing in India have also been framed by Static Control Components (SCC). The organization creates exactly 13,000 unique parts including drums, ink, housings and chips for 1,200 distinct toners and cartridges. As per International Director Sales of India SCC, the Indian market has extremely intense conditions and is immature yet has tremendous potential and this market will be vital later on with firms contributing a great deal of time, vitality and cash into it. Timken is an international leader in friction management technologies and provides one of the most complete offerings of antifriction bearings in the industry. They also offer remanufacturing options for bearings and related equipment’s. They recommend and suggest that remanufacture and repair of qualified components is frequently an economical alternative to replacing it with new ones.

4. Timken Repair Section

Timken industries offers a perfect repair solution to all its clients who have signed a contract with them. In this section, Timken offers its customers various reconditioning and remanufacturing facilities with aid of services like rectifications, reclaim, rebuild and repair. The clients are given the flexibility to choose their new specifications as per their needs.

5. Recertify, Reconditioning & Remanufacturing

This involves the renewing of the certification of a bearing, which is valid for all products with an outdated shelf life. Timken offers this service usually for its unused products. This service allows Timken to restore good condition of its bearings by polishing, honing, tumbling and other processes that involve removal of minor surface defects. Bearings being made of metals often get corroded and rusted which greatly decreases the performance as well as the life of bearings. These processes help increase these parameters. This service provided by Timken is in high demand due to its capability to bring back most of the defective bearings back to the market by converting them to bearings with life and quality of new bearings. The processes involved in this include machining, grinding, turning and many other operations that aid in fixing aggressive surface damage. In this process they also make sure to replace all the non-repairable parts with new components.

6. Potential Life Due to Repair

Life span of a bearing decreases due to corrosion, rusting and contamination. Any bearing remaining life is always inversely proportional to time in service. Regular maintenance of a bearing is very necessary to extend the life of it. Overseeing the defects and not fixing them will drastically reduce its life. Therefore it is stated that regular repair increases potential life of bearing.
7. Remanufacturing at Timken
Timken provides its clients with the state-of-the-art bearing remanufacturing facilities. It repairs and remanufactures all types of bearings from any bearing manufacturer. They ensure all their clients know that remanufacturing can help them save about 60% than purchasing a new bearing as well as shorter lead times. Providing a wide range of refurbishing/remanufacturing and maintenance services, they bring the bearings to almost its new condition. By this, the life of the bearing is considerably increased, providing economic sustainability as well as functionality. Timken manufactures various kinds of bearings involving tapered roller bearings, spherical roller bearings, cylindrical roller bearings, ball bearings, thrust bearings and many more. As per Timken, a few signs always help indicate if a bearing must be remanufactured. One of it suggests that when a bearing goes for inspection and its life is found to be near to the suggested life expectancy, if the operating temperature exceeds 200F due to vibration then the most suitable option is remanufacturing.

8. Element of Customer Expectation
Under its repair section, Timken offers recertify reclaim, reconditioning & remanufacturing services. Customer expectation generally refers to the needs and wants of any individual investing in a certain product. Meeting the parameters of customer expectations helps gain customer satisfaction. Information regarding customer expectations also helps evaluate the value and quality of existing product. Timken meets most of its clients expectation by remanufacturing of bearings due to the benefit of increased potential life. Users and clients expect the following from Timken. Most of the users are interested in remanufacturing of bearings due to its improved potential life.

Users expect the following elements from Timken.
A. Lower down Capital Cost
   Operation of plant and machinery with lowest cycle cost of component.
B. Boosting of Productivity
   The effort is to minimize the equipment delays and unproductive time with planned maintenance.
C. Enhancement of Product Quality
   User expects the enhancement of quality of product by up gradation & preventive maintenance.
D. Minimum Inventory of Factor
   User always expects to retain the optimum inventory level to control capital investment at a minimum level.

9. Remanufacturing Stages
Many EOL products are returned to the repair centre, but not all need to be remanufactured. Also it is not always advantageous to remanufacture a product so the company selects the bearings that should be sent for remanufacturing operations. Once End-of-Life (EOL) product is returned to repair centre, company selects the bearings for remanufacturing operations.
Any product brought in is first sent over to the information recording center where data regarding the actual internal clearances is recorded. This is the data necessary for disassembly and inspection of a product. The products then disassembled and parts are tagged with unique identifiers. The entire comprehensive inspection of a product involves two stages. The initial inspection covers locating major damages like fractures and bluing due to thermal damage. This inspection declares if a bearing needs basic repairs or needs to be refabricated which is the second stage of inspection. Any damaged part found to be irreparable is replaced with a new one. The others are sent over for grinding and polishing. Resetting the metallurgical and clearance aspects up to the mark is done by heating, and these are the challenges usually faced during remanufacturing. Finally the remanufactured bearing parts are tested individually and assembled. The entire bearing is then tested for quality.

10. Remanufacturing Benefits
Timken sells differing kinds of bearings within the market as per the customers’ need. The Company additionally provides repair services to clients creating a large secondary marketplace for business. Several main firms in the world purchase top quality bearings from the company with a maintenance agreement [9-11]. At the EOL of Bearings, Timken Company offers remanufactured bearings repair service. Quality of remanufactured bearing is almost of the standard of recent bearing and remanufacturing operation saves material, energy and capital investment of company. Sustainable product development is also a really necessary key issue to protect environmental pollution connected issues. Altogether, remanufactured products are useful to the OEMs and purchasers.

![Figure 3: Remanufacturing Operation](image)

Fig. 4 shows the failure rate of remanufactured bearings. The initial probability of bearing being damaged during the wearing-in period is high, however after this initial stage, bearings tend to work smoothly. Any remanufactured bearings also have a high initial failure rate, which then dips in the intermittent period but due to high fatigue, the failure rate rises again as a bearing reaches its EOL. This shows that the reliability of a remanufactured bearing is same as that of any new bearing. Here there is also a brief description put together using data collected by investigating some case studies of top Indian client companies that opt for remanufacturing as a solution. This will help us understand remanufacturing benefits.

A. Remanufacturing Benefit: Essar Steel Hot Strip Mill & Lafarge Cement
Essar Steel Hot Strip Mill (ESHSM) is one of the top Indian clients of Timken Industry. Essar Steel purchased the bearing part no. – M272749Assy902B3 & M268749 Assy90118 which were mounted on Hot Coil Box Mandrel. As soon as these bearings were approaching their EOL period, the company decided to invest in new bearings worth value of $ 27,500.

| Table1: Remanufactured Bearing ESHSM & Lafarge Cement |
|-------------------------------------------------------|
| Remanufacturing Service Offered | Timken India Ltd. | Timken India Ltd. |
| Client | Essar Steel Hot Strip Mill | Lafarge Cement |
| Bearings Part No. | M272749Assy902B3 and M268749 Assy90118 l | FAG – 51.9680A |
| Price of New Bearings | $ 27,500 | $ 102,360 |
| Price of Remanufactured Bearings offered by Timken | $ 13,475 | $ 61462 |
| Direct Cost Saving due to Remanufactured Bearings | $ 14,075 | $ 40,898 |
| Percentage of Cost Saving due to Remanufactured Bearings | 51% | 40% |
Lead Time for new bearings | 12 Months | 12 Months
---|---|---
Lead Time of Remanufactured Bearings | 04 Months | 06 Months
Percentage of Lead Time Saving due to Remanufactured Bearings | 67 % | 50 %

The process of bearing removal from the costly mandrel would be done by gas cutting operation damaging the mandrel. This is why Timken advised ESHSM to opt for remanufacturing as a repair solution. Timken’s design engineers came up with the best fixture solution, dismantling all the bearings without damaging the mandrel. After carrying out rigorous manufacturing operations for 16 weeks, Timken successfully remanufactured the EOL bearings. As mentioned in Table 1, remanufacturing of theses bearings helped save $14,075, which is higher than $13,475, the total money invested in remanufacturing saving 51% of the amount for ESHSM. Not only did ESHSM benefit from this, Timken also did, by earning more profits in remanufacturing operations. This is because remanufacturing drastically reduced the lead time, drastically increasing the productivity. Another example of the same is the Lafarge cement case, a company that entered India in 1999 through the cement market. The Company uses the bearing part no: FAG – 517680A for KHD Roller Press. According to Table 1 the company saved $40,898 by selecting remanufacturing as a solution.

The company did start by investing $102,360 in new bearings, but as soon as theses bearings reached their EOL, Timken suggested they remanufacture the old bearings just for $61,462, saving 40% of cost invested in new bearings. Not only this, Lead time for new bearings is 12 months but remanufacturing was possible in 6 months, reducing the lead time by 50%.

### B. Chock Remanufacturing

The Tinplate Company of India (TCI) is a venture started by the Tata Group and is the largest producer of tin plate since 1922. Table 2 explains the advantages of remanufacturing operation with the help on TCI’s case study. The company uses 4 Hi Skin Pass Mill Chock whose life is 12 years. At the EOL of the Product, the Company decided it’s best to replace the part by a new mill chock. This is when Timken India Ltd offered them a remanufacturing solution which proposed that it would save 67% of TCI’s revenues. The price of a new mill choke is around $60,000 and Timken India completed the operation in $14,000 without making any compromises on the quality of the product. Not only saving capital, remanufacturing also saved material and lead time. This resulted in sustainable product development by the environment protection view. Usha Martin which is a wire rope manufacturing company at Ranchi, India also preferred remanufacturing service from Timken as the cost benefit is around 60% as shown in Table 2.

| Remanufacturing Service Offered | Timken India Ltd | Timken India Ltd |
|---|---|---|
| Client | Tinplate Company of India | Usha Martin |
| Bearings Chock | 4 Hi Skin Pass Mill Chock | Bar Mill Chock |
| Price of New Chock | $ 60,000 | $ 1,25,000 |
| Price of Remanufactured Bearings Chock offered by Timken | $ 14,000 | $ 50,000 |
| Direct Cost Saving due to Remanufactured Bearings Chock | $ 46,000 | $ 75,000 |
| Percentage of Cost Saving due to Remanufactured Bearings Chock | 77 % | 60 % |
| Lead Time for new bearings | 12 Months | NA |
| Lead Time of Remanufactured Bearings Chock | 04 Months | NA |
| Percentage of Lead Time Saving due to Remanufactured Bearings Chock | 67 % | NA |

### C. Comparison of Price/ Cost Savings

Fig. 5 Portrays the benefits of remanufacturing operation in three well-known companies of India. Timken India Bearings offered remanufacturing services to many industries who are ready to accept the benefits of these services.

TCI got 77% benefits due remanufacturing operation. The amount of cost saving due to remanufacturing operation is really huge. ESHSM and Lafarge Cement also saved 51% and 40% cost due to remanufacturing operation. Companies save on the cost as well as lead time due to remanufacturing. Large amount of lead time is saved and productivity and overall profitability of organisation is increased.
11. Price Saving Due to Remanufacturing

Analysis of data derived by four companies is used for calculation of maximum cost saving due to remanufacturing. Companies such as ESHSM, Lafarge Cement, TCI and Usha Martin benefited due to remanufacturing operation and is as shown in Table 1&2.

### Table 3: Expected Remanufactured Bearings Cost Saving

| Case | Null Hypothesis | Alternative Hypothesis | t-test, Level of Significance | Population Distribution | Standard Deviation | t | Null Hypothesis | Alternative Hypothesis | μ | μ1 | μ2 |
|------|-----------------|-----------------------|-----------------------------|------------------------|-------------------|---|-----------------|-----------------------|---|-----|-----|
| I    | μ=68.66 %       | μ1=68.66 %            | -2.353                     | N ~4                   | 9.11 %            | - | -2.353 < 2.353 | 68.66 %               | 68.66 % | 68.66 % |
| II   | μ=62.66 %       | μ1=62.66 %            | 2.5246                     | N ~4                   | 9.11 %            | 2 | 2.5246 > 2.353 | 62.66 %               | 62.66 % | 62.66 % |

The maximum cost saving due to remanufacturing is calculated by taking an average of the top two values which is about 68.7%, with the average cost saving to be about 57%. It is interesting to find the nearby value of cost saving due to remanufacturing. On available data as shown in Table 3, t-test is the most feasible analysis to find out nearby value of cost saving due to remanufacturing. Null hypothesis & alternative hypothesis have been shown in the table 3. In Case I, value of t-test is less than -2.353 and hence null hypothesis is rejected and alternative hypothesis μ<68.5% has been accepted. Since the value of μ<68.5%, we conducted case II, as it is necessary to find nearby value of cost saving percentage due to remanufacturing. From case II, it is seen that the expected cost saving due to remanufacturing is 62.66% i.e. average of top three values of cost saving percentage. In the t-test, it has been proved that null hypothesis is accepted and μ<62.66 % (see the table 3). Due to the remanufacturing initiative taken by Timken, bearings in the Indian market saved cost up to around 62.66% and this is really a significant cost saving.

12. Cannibalization Issues in Indian Market

Product cannibalization is the term used for drastic reduction in sales volume, sales revenue or market share of any existing product as a result of introduction of a new product by the same or any competitor manufacturer. Many companies carefully plan a strategy to use the negative impacts of product cannibalization to their bone. Product cannibalization due to entry of a new product is a very common occurring in the market, but here in this paper we are discussing cannibalization due to the entry of remanufactured products, and how it has become a big issue for the OEMs [7-8]. The entry of a remanufactured product completely starts a new product life cycle which is same as the product life cycle of an existing product. The above analysis of cases have proven that remanufactured products are always profitable for the OEMs and customers. However many Indian OEMs have the fear of cannibalization of their new products due to the entry of remanufactured products. What they do not see yet is that OEMs can also profit by starting remanufacturing/Refurbishing business along with new product development, without fearing cannibalization by deciding which process is profitable when. Timken is the best example that suggests the same. The important questions to be asked are why are industries not using remanufacturing options to its clients? And is the profit percentage of remanufactured products more than the profit percentage of new products? The cost associated to the remanufactured products is comparatively lower than that of new products, and this can be proved by the bearings/chocks cases addressed by Timken. The only reason of this cost precent difference being reduction of new material, reduction of lead times and therefore reduction of hours input by labour, saving up on primary and secondary expenses a company has to make for product development. Due to these factors, any company offers remanufactured products at a lower rate, which is also beneficial for the clients. A top manufacturer like Timken is positively grabbing both the new product as well as their manufacturing market, as not all items can be profitably remanufactured. It is important to gain the clients trust by giving the correct advice that is not only beneficial to one’s own business but also the customer, making the entire situation a win-win one. Timken has grabbed the remanufacturing market as a secondary source of income which has proven to be highly beneficial. An OEM needs to well understand the fact that if due to their fear of new product cannibalization they do not enter the remanufacturing market; other competitors will take lead into this sector cannibalizing their product. Now that it has been proven that entering the remanufacturing sector increases the overall profitability, Indian OEMs need to change their perception about cannibalization concerns and need to enter the remanufacturing market. There is a lot of scope of Indian manufacturers and OEMs to shine in the remanufacturing sector, which is in turn expected to boost the economy as well as create thousands of job opportunities here, however the Indian OEMs oppose free globe trading of remanufactured products. The Indian government also does not permit the trading of remanufactured items within the country. The Indian government needs to have a wider spectrum regarding the same and see how it is going to help the Indian economy reach the sky. All that is needed is a little consideration and encouragement.

13. Conclusion

The fear of product cannibalization of new products has reached to the Original Equipment Manufacturers up to such an extent that they are always posing free globe trading of remanufactured products in India. However it is found that the Indian market has huge potential to rise in the remanufacturing industry. This is proven as the cartridge industries have shown remarkable impact of remanufacturing over the last decade. The remanufacturing industry is still at a very naïve position in the Indian market and in the upcoming years it is expected to leave a very positive impact on the market. For boosting the economy of the country, the government of India must permit free globe trading of remanufactured products in the country. In this research paper, the effects of
remanufacturing services in the market are depicted and understood by taking help of the case study of an OEM, Timken. Timken is seen providing remanufacturing solutions to its Indian clients like Essar Steel Hot Mill, Lafarge Cement, Tinplate Company of India and Usha Martin. Remanufacturing of EOL bearings and mill chock on an average resulted in 57% of cost saving as compared to new price. A T-test, which is a test to calculate the nearby value of cost saving due to remanufacturing, was conducted on observed values were noted as shown in Table 3. Analysis shows that 62.66% of the cost is saved due to remanufactured products. Remanufacturing facility not only helps in cost cutting but also reduces lead time and this helps in improving productivity. It is evidently noticed that Timken has earned healthy profits as the outcome of its remanufacturing services. Instead of cannibalizing the new product, remanufacturing increased the overall profit of the OEM. Not only Timken but many other industries are also helping their customers by providing remanufacturing solutions, and the Indian market must accept these products with open arms. This will not only help save the Indian economy but also help boost awareness about these products and processes in the market.

After all it is said that poverty is not only measured in the terms of money, but also knowledge. This will not only help save the Indian economy but also help boost awareness about these products and processes in the market. After all it is said that poverty is not only measured in the terms of money, but also knowledge.

14. References

1. W.M. Hauser and R.T. Lund, (May 2008). “Remanufacturing: Operating Practices and Strategies,” Boston University.
2. M. Ferguson, (2009). “Strategic Issues in Closed-Loop Supply Chains with Remanufacturing,” College of Management, Georgia Tech, Atlanta, GA 30332.
3. H. Vasudevan, V. Kalamkar. And R. Terkar, (November 10-12, 2011). “Product Cannibalization due to Remanufacturing and its Decisive Strategies,” International Conference on Sustainable Manufacturing: Issues, Trends, and Practices, Bito, Plani, pp. 13-18.
4. Johan Ostlin, Erik Sundin and Mats Björkman, (2009). “Product Lifecycle Implications for Remanufacturing Strategies,” Journal of Cleaner Production, 17(11), pp. 999-1009.
5. H. Hermansson and E. Sundin, (2005) “Managing the Remanufacturing Organization for an Optimal PLC,” I-4244-0081-3/05/$20.00 ©) IEEE.
6. V.D.R. Guide, (2000). “Production planning and control for remanufacturing: Industry practice and research needs,” Journal of Operations Management 18, 2000, 467-483.
7. V.D.R. Guide and Li, J, (2010). “The Potential for Cannibalization of New Products Sales by Remanufactured Products,” Decision Sciences Journal, Volume 41 Number 3.
8. M. Shu, V.D.R. Guide and L.-N. Vassenhove, (2010). “So what if remanufacturing cannibalizes my new product sales?” California Management Review, Vol. 52, No. 2, CMR.Berkeley. Edu.
9. L. Debo, L. Toktay and L. Vassenhove, (2005). “Life Cycle Dynamics for Portfolios with Remanufactured Products,” Carnegie Bosch Institute.
10. M. Matsumoto and Y. Umeda, (2011). “An analysis of remanufacturing practices in Japan,” Journal of Remanufacturing, Springer open journal.
11. Y. Ogushi and M. Kandlikar, (2005). “The Impact of End-of-Life Vehicle Recycling Law on Automobile Recovery in Japan,” 1-4244-0081-3/05/$20.00 @ 2005 IEEE.
12. R. Terkar, H. Vasudevan, (November 17-19, 2011). “Need for Product Cannibalization in Small Scale Manufacturing Industries through Product Life Cycle Management,” International Conference on Modern Trends in Industrial Engineering, November 17-19, 2011 S.V. National Institute of Technology, Surat – 395 007, Gujarat, India.
13. R. Terkar, H. Vasudevan, V. Sunnapwar and V. Kalamkar, (2011). “Perfect Product Launching Strategies in the Context of Survival of Small Scale Consumer Product industries,” ICSTM 2011, CCIS 145, pp. 321-326.
14. R. Terkar, H. Vasudevan, V. Sunnapwar and V. Kalamkar, (2011). “Importance of Innovative Product Launching and Product Life Cycle Management in Small Scale Consumer Industries,” International Journal of Computer Application, Number-3, Article-2.
15. Wi Jun-yu, Y. and Wei, ZHAOyti, (2010). “Points worth Re-Consideration Concerning Product Life Cycle Management,” IEEE.
16. Savvary and M.L. Wassenhove, (2009). “Remanufacturing as a Marketing Strategy,” Management Science Vol. 54 (10), pp. 1731-1747.
17. Peizhi, Y. Jukun and Qian, Z. Sheng, (2010). “Information-based Remanufacturing Upgrade Study,” ICRM2010-Green Manufacturing, Ningbo, China.
18. Sasikumar, G Kannan, (2008). “Issues in reverse supply chains, part I: end-of-life product recovery and inventory management - an overview,” International Journal of Sustainable Engineering, Volume: 1, Issue: 3, Publisher: Taylor & Francis, Pages: 154-172.
19. Kim, H. W., and D. H. Lee., (2017). “An Optimal Algorithm for Selective Disassembly Sequencing with Sequence-Dependent Set-Ups in Parallel Disassembly Environment,” International Journal of Production Research 1–17.
20. Yan., W., Chai, J., Qian., Z., Tsai, S.B., Chen, H., Xiong, Y., (2018). “Operational Decisions on Remanufacturing Outsourcing Involved with Corporate Environmental and Social Responsibility—A Sustainable Perspective,” Sustainability 2018, 10, 1132.
21. Rajeev, A.; Pati, R.K.; Padhi, S.S.; Govindan, K., (2017). “Evolution of sustainability in supply chain management: A literature review,” J. Clean. Prod. 2017, 162, 299–314.
22. Vasudevan, Hari, Vilas Kalamkar, and Ravi Terkar. “Remanufacturing for Sustainable Development: Key Challenges, Elements, and Benefits.” International Journal of Innovation, Management and Technology 3, no. 1 (2012): 84.