

PROSPECTS OF REMANUFACTURING: A BANGLADESH PERSPECTIVE

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Environmental concern of waste materials and product disposals has encouraged some companies to operate their businesses more efficiently while minimizing waste. One of the ways to achieve this purpose is by taking back end-of-life products for remanufacture for life extension. Since the quantity of returned product is uncertain and its quality is not always good, so the companies still need to produce new products to fulfill their customer demand. Hence, they need to put both manufacturing and remanufacturing together in one system. This research will address the possibilities and scope of remanufacturing in Bangladesh. This research has investigated and analyzed the industry sectors, the scope of products to be remanufactured and how the world is getting benefits from remanufacturing. Also this research is going to discuss the existing practices of Remanufacturing worldwide especially USA and how Bangladesh can be benefitted from this comparing to other countries. The outcome of this research will encourage companies to undertake sustainable manufacturing strategies in their manufacturing system.

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1. REMANUFACTURING: BACKGROUND AND REVIEW

1.1 What is Remanufacturing?

Remanufacturing is the process of disassembly of products during which time parts are cleaned, repaired or replaced then reassembled to sound working condition.

A product is considered to be remanufactured if:

- Its primary components come from a used product.
- The used product is dismantled to the extent necessary to determine the condition of its components.
- The used product's components are thoroughly cleaned and made free from rust and corrosion.
- All missing, defective, broken or substantially worn parts are either restored to sound, functionally good condition, or they are replaced with new, remanufactured, or sound, functionally good used parts.
- To put the product in sound working condition, such machining, rewinding, refinishing or other operations are performed as necessary.
- The product is reassembled and a determination is made that it will operate like a similar new product.

There are hundreds of distinct products that are being remanufactured. The following is just a short list of some of these products: 1. Motor Vehicle Parts 2. Office Furniture 3. Compressors 4. Electrical Apparatus 5. Vending Machines 6. Photo Copiers 7. Laser Toner Cartridges 8. Data Communication Equipment 9. Gaming Machines 10. Musical Instruments 11. Robots 12. Aircraft parts 13. Bakery Equipment 14. Much, Much More

Figure 1 below shows a typical manufacturing re-manufacturing system. Two major important stages during recovery of used products are, i) De-manufacturing ii) Re-manufacturing. De-manufacturing involves disassembly, sorting, cleaning, and material separation to various levels of purity. Remanufacturing consists of repairing, refurbishing, reassembly, repackaging, and material compounding or synthesis [1]. Our concern in this research is to combine re-manufacturing part of end of used products (EOUP's) and new product manufacturing.

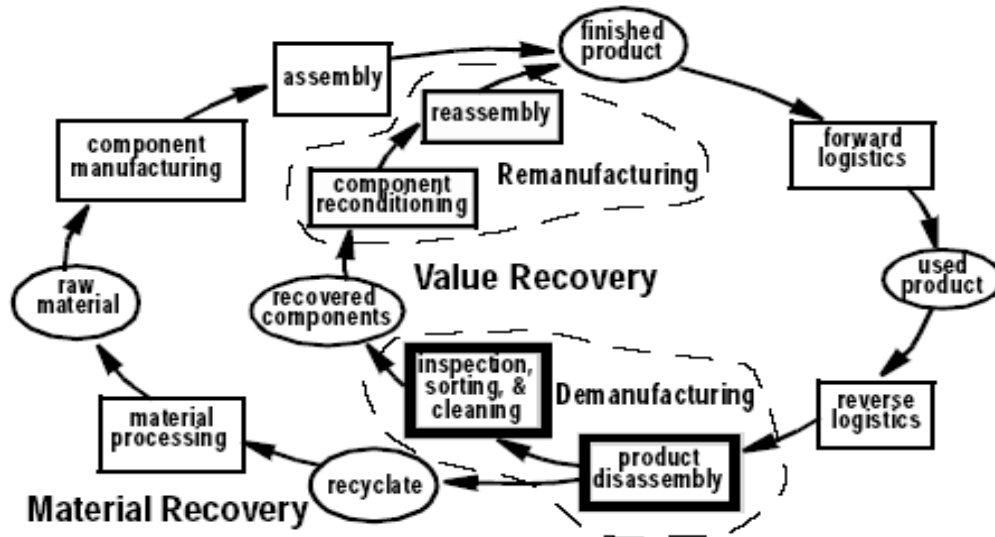


Figure 1. A typical manufacturing –remanufacturing system.

The flow of materials and products in this environment occurs both from the customer to the remanufacturer (reverse flow), and from the remanufacturer to the customer (forward flow). Since most of the products and materials may be conserved, essentially this forms a closed-loop logistics system [1].

1.2 Remanufacturing worldwide

Extensive research works have been done and still running in the field of remanufacturing worldwide. We will present some of the research outcome here that motivated us to do research in this area. We will see how the world business enterprises, economies and societies are getting benefitted by remanufacturing. These trends and practices can be very encouraging for Bangladeshi Industries to take remanufacturing strategy in their system.

How world business enterprises getting benefit from remanufacturing

The argument for an enterprise to enter the business of remanufacturing products or distributing remanufactured ones is compelling. Original equipment manufacturers (OEMs) like General Electric, Boeing, Caterpillar, Deere, Navistar, Xerox, and Pitney Bowes have created business models in which capital goods remanufacturing is an integral part. They currently lease, remanufacture, and remarket an estimated \$130 billion of assets. In the consumer durable goods case, most automotive OEMs, directly or indirectly, engage in some level of remanufacturing, with the used parts generally sold through the same distributor network used for new ones. Eastman Kodak and Fuji Photo Film have revolutionized

Tables 1 and 2. Some example from US enterprises.

Table 1: Size and scope of remanufacturing activity in the US

Total number of firms 73,000
 Total annual industry sales \$53 billion
 Total direct employment 480,000
 Average annual company sales \$2.9 million
 Average company employment 24
 Number of product areas Over 46 major categories
 Source: Lund (1996)

Table 2. Relative size of remanufacturing activity in the US

Industry sector Employment Shipment value
 Remanufacturing 480,000 \$53 billion
 Household consumer durables 495,000 \$51 billion
 Steel mill products 241,000 \$56 billion
 Computers & peripherals 200,000 \$56 billion
 Pharmaceuticals 194,000 \$68 billion

photography with their single-use cameras, but most consumers are unaware that the cameras are remanufactured up to 10 times after being returned for film processing. As far back as the 1930s, when Henry Ford began remanufacturing

automobile engines after the Great Depression brought new car sales to a standstill, companies with an eye to the future have recognized and capitalized on this untapped opportunity. Many enterprises are stakeholders in the successful expansion of remanufacturing. The list below, gives some examples: i) Firms that use remanufactured products, enabling them to reduce their capital investment expenditures ii) OEMs, which can use the remanufacturing process and the remarketing of the resulting products as a business strategy to increase profits. iii) Manufacturers of specialized equipment used in the process, such as cleaning and test equipment, optical gauges, and so on. iv) OEM stockholders, who would likely see greater growth and stability in their investments v) Information technology suppliers, who would help build the IT infrastructure to support remanufacturing and distribution process activities vi) Management consultants, who would assist new-condition product manufacturers in incorporating remanufacturing into their business models vii) Design engineering software suppliers, who would develop design optimization tools for the remanufacturing processes of disassembly and reassembly viii) Financial service firms, which would finance the capital investment needed for companies to enter the remanufacturing sector ix) Third-party logistics suppliers, which would experience a large increase in reverse logistics activity.

How consumers are getting benefit from remanufacturing

Remanufacturing brings lower prices to the consumer, typically on the order of 30 to 40 percent less than similar new products. It also means more consumer choice, especially for discontinued products that are still available in mint condition, which is currently the case in such industries as retail auto parts.

How Societies are getting benefit from re-manufacturing

Society is arguably the greatest beneficiary of remanufacturing. As a material productivity initiative, the process has an intrinsic societal benefit in that it reduces the volume of energy and natural resources required to produce the goods we value. Remanufactured products incur costs that are typically 40 to 65 percent less than those incurred in the delivery of new products. This is because most of the raw materials already exist in their final form and thus require only a fraction of the material processing required of new products. In terms of energy consumption, remanufacturing a product requires only about 15 percent of the energy used to make the product from scratch. The estimated worldwide energy savings of current remanufacturing in lieu of building new products is an incredible 400 trillion BTUs of energy annually. To put that figure into perspective, it is the equivalent of about 16 million barrels of crude oil (about 350 tankers), or enough gasoline to run 6 million cars for a year. As a direct result of the energy savings, remanufacturing is also extremely effective in reducing greenhouse gas emissions. A weighted average of 140 pounds of CO₂ is emitted for every million BTUs of energy consumed (burning coal is higher, hydroelectric and nuclear lower). Based on its estimated savings of 400 trillion BTUs per year, remanufacturing avoids the generation of about 28 million tons of CO₂ annually, roughly the output of ten 500-megawatt coal-burning electrical plants.

The estimated savings in raw materials is equally compelling the materials saved would fill 155,000 railway cars in a train spanning 1,100 miles. While recycling has a similar effect in terms of conserving natural resources, it requires that the parts be returned to their raw state (which requires energy), at which point the manufacturing process must be repeated just as if virgin raw materials were used (which also requires energy). All these energy savings are only the tip of the iceberg. It has been estimated that if capital goods OEMs and automakers delivered 20 and 10 percent of their product output, respectively, in a remanufactured rather than new condition, remanufacturing activity in the United States would increase by 200 percent. That equates to an estimated 5 to 10 percent drop in waste and energy consumption throughout the entire US manufacturing supply chain.

European governments have taken an aggressive stance in favor of remanufacturing. As of 2002, for example, no more than 15 percent of a scrap vehicle can be discarded in Europe, with that percentage dropping to 5 percent by 2015, coupled with the mandate that a percentage of automobiles sold each year must be remanufactured. The German Packaging Order and the German Recycling and Waste Control Act are models of how to establish green legislation to drive remanufacturing.

New York passed a remanufacturing bill in June 1998 (by a vote of 146–1) mandating that purchase requests for durable equipment consider remade goods first. It also mandates that “products purchased by the commissioner or other state agencies shall be recycled or remanufactured products...provided the cost...does not exceed a cost premium of ten percent.” Finally, it prohibits state agencies from purchasing commodities from OEMs that place restrictions on remanufacturing, such as Lexmark with its “Prebate” program. The following year, Texas, Connecticut, and California passed similar laws. In 2000, New York added to its landmark legislation by passing a tax credit to benefit remanufacturing firms.

1.3. Remanufacturing in Bangladesh

The actual scenario in manufacturing and remanufacturing industries in Bangladesh is yet to expand as the country is still growing and expanding all the way through the technology in the long run to the competitive perspective. We have investigated the manufacturing sectors and the products that can be remanufactured. Some of them are presented on the table 3.

The industrial sectors and the products shown in table 3 are promising for remanufacturing in Bangladesh [7]. During our investigation we have talked to the authorities of different industries. Maximum of the companies are not practicing remanufacturing in their system. They don't have proper knowledge about how to manage manufacturing and remanufacturing simultaneously in their system. Also how to schedule the production and manage inventories in such hybrid system is a big question to them. Also they are fear about the result of implementing such policy. One thing they agreed during our study is that huge value they are losing not to take back the used products. They acknowledged that even sometimes they can regain up to 70-80% value from used products. Due to the lack of awareness and knowledge of managing such system is a dominant reason for not taking remanufacturing in their system. Some companies are practicing re-manufacturing but their activities are very limited. Plastic product manufacturers in Bangladesh are doing re-cycling but not remanufacturing. The difference is that the value we regain from recycling, of them 60-80% we normally lose due to energy consume, manpower and doing other activities to get the product in a usable shape. Other manufacturing companies are practicing this in a very limited manner and are not professionally managing remanufacturing system.

Table 3. Remanufacturing sectors and products in Bangladesh

| Industry Sectors | Products |
|------------------------------|--|
| Automotive | Alternators, Starter Motors, Water Pumps, Clutches and Engines |
| Compressors & Refrigeration | Air conditioner and Refrigerator Compressor. |
| Electrical Apparatus | Transformers, Electrical Motors and Switch ,Gear, Battery |
| Machinery | Machinery and Equipment for various industries |
| Office Furniture | Desks, Files and Partitions |
| Tires, retreaded | Truck, Auto and Off-road Tires |
| Toner Cartridges | Laser toner cartridges Ink jet cartridges |
| Valves, industrial | Control & Relief valves |
| Gaming machines | |
| Musical Instruments | |
| Aircrafts Parts | |
| Robots | |
| Bakery Equipments | |
| Data communication equipment | |

Actually, it is very difficult to quantify how much impact will be on turnover at this moment as they are not practicing it professionally, but experience from other countries we can say that it has great impact on the company's profit margin. Our future research will be to quantify exactly how much it affects to company's profit margin.

We know environmental concern is very important now a day. Industries are making waste and throwing them in the environment. Bangladesh is a severely polluted country by industrial waste. So at present the burning issue is how to protect environment from waste. The only way is to achieve sustainable manufacturing system. If we can minimize the rate of waste we are throwing to the environment, it will be less polluted. The most popular and effective way is to remanufacture the used product. By re-manufacturing we can regain the values up to 85%, while the total product normally goes to the environment as waste if we don't do that. In Bangladesh we are not practicing environmentally conscious manufacturing policy for our system. Now it is time to think about it. We are taking some measures for environmental concern such as ETP and so on. But, where possible, re-manufacture is the most effective way to save business as well environment. So In Bangladesh we should start practicing it from today.

2. RECOMMENDATIONS FOR FUTURE RESEARCH

There are some future dimensions of this research to be carried out. From Bangladesh perspective there will be two dimensions of this research

- a) **If the company already practices re-manufacturing in their system:** In this case our concern will be the following areas, i) The background for taking this strategy ii) How are they implementing iii) How much the impact on the profitability iv) Areas for improvement.
- b) **If the company does not practice re-manufacturing in their system:** In this case we will concentrate on the following issues, i) Feasibility study for taking re-manufacturing ii) Identify the products to be re-manufactured iii) Calculate the impact on turnover iv) Suggest Implementation techniques.

Also, we have the opportunity to do research in the area of inventory management in a manufacturing-remanufacturing hybrid system. There are many problems managing inventory in such hybrid system. So investigating the problems we need to build a mathematical model addressing the problems. There are many mathematical models we have in the area of manufacturing but we need to develop a model that combines manufacturing and remanufacturing systems in a single model. When to combine re-manufacturing with manufacturing some uncertainties are to be addressed. One of the major challenges in managing such hybrid systems is the stochastic nature of product returns. In particular, there is significant variability in the condition of the returned products. In a traditional manufacturing environment, the exact parts requirements are known for each unit to be assembled. For remanufacturing, however, the new parts requirements are not known because the used core products are the primary source of supply for parts. The number of usable parts from cores, unfortunately, is not usually known until after the core is disassembled, inspected, and tested. So, this research has a very good opportunity to get significant outcome in future research. We will continue this research towards the shown path above and hope, we will be able to present significant outcomes to the readers in future.

3. CONCLUSION

Product returns are increasingly a concern to industry. At present, only a very small percentage of the value is being recovered. Many firms still view product recovery activities as a nuisance and this prevents them from recognizing potential value creation activities. Remanufacturing provides the customer with an opportunity to acquire a product that meets the original product standards at a lower price than a new product [3]. Recoverable manufacturing systems minimize the environmental impact of industry by reusing materials, reducing energy use, and reducing the need to landfill industrial products. These systems are widespread in the world and are profitable, in addition to contributing to sustainable development. In Bangladesh there is a very good prospect for remanufacturing. If we can implement re-manufacturing in our system it will affect greatly in turnover of our manufacturing industries.

4. REFERENCES

- [1] K. L. Gunter¹, D. J. Bee^{1,2}, and J. W. Sutherland¹” Inventory Management in De-manufacturing Facilities” ¹Michigan Technological University, Dept. of Mechanical Engineering – Engineering Mechanics ²University of Wisconsin - Stout, CTEM
- [2] V. Wohlgemuth¹, B. Page¹, W. Kreutzer², O.Gromyko¹, L.Heydt¹” Modelling Economic and Ecological Aspects of Inventory Management Strategies within a Component-based Material-flow Simulator” University of Hamburg, Department for Informatics, Center for Architecture and Design of IT-Systems (AGIS), Vogt-Kölln-Str. 30, 22527 Hamburg.
- [3]. 2008 ,Atalay Atasul, V. Daniel R. Guide, Jr.², Luk N. Van Wassenhove³” Product Reuse Economics in Closed-Loop Supply Chain Research “¹College of Management, Georgia Institute of Technology, Atlanta, GA 30332 USA, ²Smeal College of Business, The Pennsylvania State University, University Park PA 16802 USA, dguide@psu.edu³INSEAD, Technology & Operations Management, Fontainebleau France,
- [4]. Mattias Lindahl, Erik Sundin and Johan Östlin,” Environmental Issues within the Remanufacturing Industry” 13th CIRP INTERNATIONAL CONFERENCE ON LIFE CYCLE ENGINEERING
- [5]. Karl Inderfurth, Ruud H. Teunter.” Production planning and control of closed-loop supply chains”, Econometric Institute Report EI 2001 - 39
- [6]. Ron Giuntini, Kevin Gaudette,2003.” Remanufacturing: The next great opportunity for boosting US productivity”, business horizons,pp-41-48
- [7] Report on Bangladesh census of manufacturing industries(CMI) April 2007
- [8] Statistical pocket book of Bangladesh 2008.
- [9] Statistical year book of Bangladesh, 28th edition, March 2009

BIOGRAPHICAL SKETCH



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