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ORIGINAL RESEARCH

Optimal Configuration Strategies for a Remanufacturing Firm: A Conceptual Framework

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Abstract
This research presents a conceptual framework to analyze the remanufacturing strategy. Three configuration strategies are explained and explored, namely Hybrid Manufacturing and Remanufacturing System (HMRS), Manufacturing/Remanufacturing (M/R) and Remanufacturer to the Manufacturer (R2M). Our research focuses on the cost and pricing decisions that affect the manufacturing firm to opt for the best-suited configuration. The competitive advantage is gained by manufacturing firms adopting remanufacturing or hybrid manufacturing and remanufacturing system. This conceptual framework will help manufacturing firms adopt the best-suited configuration and provide a decision-making framework for the variables within control and collaborative factors in remanufacturing.

Keywords Competitiveness · Hybrid manufacturing and remanufacturing system (HMRS) · Decision support system · Collaboration · Configuration

JEL Classification L16 · L11

Introduction

The correlation among the environment and manufacturing operations is gradually fetching recognition from academia and industry worldwide. This results in considering environmental concerns and manufacturing organisations' profitability while creating strategies (Sarkis, 2001). Increasing efforts for sustainability while preserving productivity and profitability are progressively seen as strategic objectives of manufacturing enterprises (Seuring & Müller, 2008). Remanufacturing is one of the prominent strategies firms implement to achieve the sustainability of processes (Mahapatra et al., 2013; Rosen & Kishawy, 2012). The definition of remanufacturing given by Remanufacturing Industries Council (2017)[1] is –

> "… Remanufacturing is a comprehensive and rigorous industrial process by which a previously sold, worn, or non-functional product or component is returned to a like-new or better-than-new condition and warranted in performance level and quality …"

The remanufactured products are expected to offer a cost-saving of 40% compared to the virgin products to customers, which helps reduce the environmental impact. However, remanufacturing, compared to manufacturing, needs a devoted return management process for successful operationalization (Ambilkar et al., 2021). The success of the remanufacturing process is mainly determined by the effective and efficient collection of used products (Vercraene et al., 2014; Zhao et al., 2017).

In some industries, equipment manufacturers succeed in collecting used products in parallel with the circulation of new products. Returns management or reverse logistics is critical for carrying out core acquisition in remanufacturing (Fu et al., 2019). Due to the lack of consciousness, users/customers do not return their used products through the available reverse logistics (RL) channels which hinders the collection and remanufacturing process (Geyer & Blass, 2010). It is imperative to have a robust reverse logistics channel and

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flexible production planning to maximise a firm's profits and overall competitiveness (De Rosa et al., 2013).

Researchers put forth an integrated system called a Hybrid manufacturing and remanufacturing system (HMRS) (Bhide & Akarte, 2022; Polotski et al.. 2015; Flapper et al., 2014). It involves the production of new as well as re-manufacturable components. Production planning activity in a closed-loop supply chain involving the HMRS is very complex, especially regarding uncertainties.

Considering the legislative, economic, and environmental constraints, the manufacturing strategy implemented to do the required activities throughout the closed-loop supply chain (CLSC) must be determined. For this reason, a carefully designed closed-loop system is necessary to achieve an optimum trade-off between long-term performance, such as cost and sustainability (Mitra, 2016b). The decision-making process should also consider the nature of the manufacturer's relationships with other stakeholders, such as suppliers, retailers, distributors, and customers (Xiong et al., 2016).

A manufacturing firm has to take a strategic decision of choosing the most appropriate manufacturing strategy (MS) from the different options, including—cost leadership, product differentiation, sterilisation, green/sustainable manufacturing strategy, etc. to retain a competitive advantage in the market (Dohale et al., 2022). Remanufacturing is one of the core strategic decisions within the sustainable MS. Remanufactured products function practically, and new ones attract price-sensitive customers (Mitra, 2016a). Another class of customers might primarily favour new products but cannot afford them. Here affordability is posed as a critical barrier. In developing countries like India, markets are dominated by price-sensitive customers (Chakraborty et al., 2019). Pricing strategies for such customers should be appropriately done to tap the market share (Kumar & Ramachandran, 2016). The pricing of end products (both remanufactured and new) directly influences the products' demand. The segmentation of customers is done by differential pricing levels. This differential pricing is vital for handling revenues when remanufactured and new products are involved. Profits can be maximised by pricing new products at higher level from customers willing to pay more. These customers feel the higher-priced original products as possessing superior value. Similarly, when priced lower, the remanufactured products will seize demand from consumers who cannot give the higher price for a virgin product but yet desire to get the greater functionality from the remanufactured varieties of such goods (Mitra, 2016a).

Manufacturing firms may consider remanufacturing either by acquiring or collaborating with the remanufacturers. The decision is based on mainly four components, namely—(1) Production cost comparison of new and remanufactured products, (2) Selling price comparison of new and remanufactured products, (3) Recovery efforts, i.e., recollection percentage, and (4) Quality of returns. Top management or manufacturing strategist has to make a crucial decision about—(1) Producing the virgin and remanufactured products in-house, i.e., hybrid manufacturing and remanufacturing system (HMRS), (2) Dealing with the manufacturing of only virgin products without considering the remanufacturing activity, i.e., manufacturing and remanufacturing separately (M/R), (3) Producing a virgin product in house and outsource the remanufactured components from a third-party remanufacturer, i.e., remanufacturer to the manufacturer (R2M). Selecting an appropriate remanufacturing decision among the three is critical for organisations to achieve long-term competitiveness. However, the literature is scant to address this aspect. This research attempts to provide a conceptual framework as a decision support tool to decide the suitable one for the policy mentioned earlier, i.e., HMRS, M/R, and R2M. To do so, this study attempts to answer the following research questions (RQs)—

RQ1. How does the cost parameter influence the manufacturer to select the best configuration?
RQ2. How does the pricing decision affect the manufacturer in selecting the best configuration?
RQ3. How do recovery efforts affect the configuration selection decision?
RQ4. How does the quality of returns affect the configuration selection decision?

Study Findings

This research will help manufacturing firms to analyse various configurations and their relationships with each stakeholder. This paper attempt to address this issue by pin-pointing the structure of manufacturer and remanufacturer while serving the customer demands.

Need for Inclusion of Remanufacturing in Manufacturing Strategy

In a supply chain, who performs the remanufacturing; whether the Original equipment manufacturer (OEM), a third-party (3P) or both? This question influences the management of income of these products. For example, if the Original equipment manufacturer does remanufacture, the customers trust the remanufactured products more and are willing to pay further because of the apparent higher quality (Ovchinnikov, 2011). However, occasionally both OEM and 3Ps also indulge in remanufacturing. Sometimes only 3Ps participate in this business, thus steering to a condition of no contest from the OEM for the new products. For example, in the case of remanufactured printer cartridges, both OEMs and 3Ps are engaged in it. However, in the instance of rubber

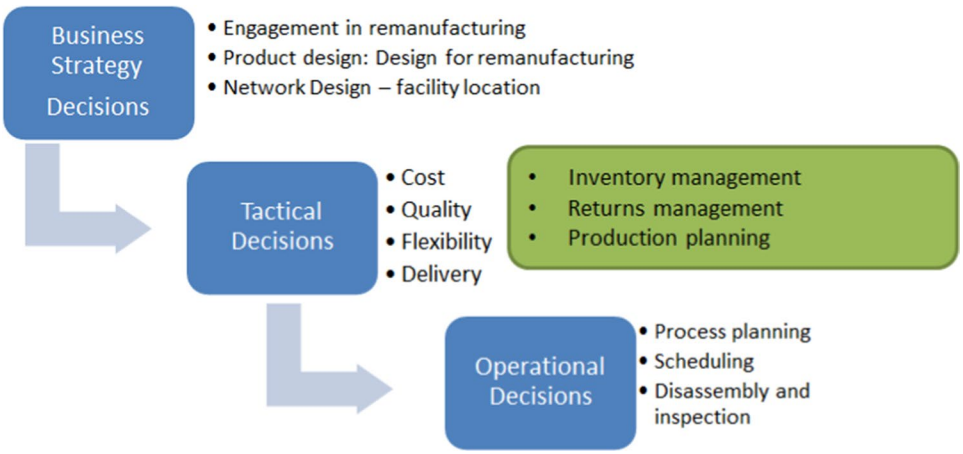


Fig. 1 Areas related to decision-making in remanufacturing. Adopted from Rizova et al. (2020)

remanufacturing, it is typically the 3Ps which participate in remanufacturing.

From a supply chain viewpoint, topics that need to be explored more are the consequence of inventory issues for both returned and finished remanufactured goods and the consequence of who in the supply chain is performing the remanufacture activity. Whether is 3P, OEM, or both OEM and 3P? This research attempts to conceptualize the competitive configuration in the context of remanufacturing strategy.

The remainder of the paper is structured as follows. An assessment of the research previously published is presented in "Literature Review" section. "Conceptual Framework" section elaborates on the conceptual framework. The managerial implication and conclusion section concludes the paper.

Literature Review

Rizova et al. (2020) conducted a thorough literature review of decision-making in remanufacturing. They have categorized decision-making areas into three groups: strategic, tactical, and operational. Engagement in remanufacturing, network design and supply chain coordination are strategic decisions.

The strategic decisions are taken by top management to cope with the corporate and business strategy. These decisions have long-lasting impacts on the business. In the case of businesses thinking of manufacturing strategy and their probable engagement in remanufacturing activity to adhere to their corporate strategy, the top management must make an informed decision about their manufacturing strategy and network design required to close the forward and reverse supply chain.

Competitive advantage in terms of cost, quality, flexibility and delivery could be achieved through tactical decisions such as inventory management, returns management, production planning and control. Lastly, operational decisions, such as scheduling, process planning, disassembly, and inspection of the recovered products, is made at the shop floor level. The levels of decisions are depicted in Fig. 1. A manufacturing firm has to decide whether to opt for remanufacturing is the topmost strategic decision. This decision is based on several factors, namely—

Remanufacturable Design of the Product

One particular research area in remanufacturing is the concept of 'design for remanufacture' (DfRem). Research has specified that whether a product is suitable for remanufacturing depends on decisions made during the design process. Specific product properties may positively or negatively affect certain remanufacturing process steps, such as disassembly or cleaning. (Hatcher et al., 2011).

Supply Chain Coordination

Supply chain coordination is key to achieving the supply chain goal, i.e., customer satisfaction (Fung & Chen, 2005). Researchers have suggested various instruments such as sharing information among actors, incentives such as rewards (Giannetti et al., 2013), and profit-sharing contracts (Jian et al., 2021) to improve supply chain coordination in remanufacturing.

Supply chain coordination is a collaborative strategy to enhance supply chain performance. To understand the relation between the actors under study, collaboration among manufacturers, remanufacturers and collection of the used product through collectors/retailers are studied in depth. H. Jian et al. (2019) studied collaborative collection strategies for closed-loop supply chains. The authors compared four models, specifically—the centralized model (C-Model), unit transfer price model (P-Model), unilateral cost-sharing model (U-Model) and bilateral cost-sharing model (B-Model). These models are based on sharing of costs for

collection. Another research in the collaborative domain explains recovery efficiency in terms of collection rate is studied but aspects of the quality of returns still need to be included in the study (He et al., 2019).

Customer Participation

While numerous studies have centred on technical features of reverse logistics, behavioural facets, and location of bins. Behaviour can be encouraged by the interplay of situational and personal factors. Kevin van Langen et al. (2021) investigated the attractiveness of various incentives such as exchanging used equipment for the money, home collection, and exchange for new equipment, tax benefits, and discount coupons. Ghoreishi et al. (2011), while modelling for cost–benefit analysis of take-back, explored incentives such as cash incentives, a discount of a certain value for purchasing new products (usually of a similar type), or a percentage discount for purchasing new products (Ghoreishi et al., 2011).

Pricing

The pricing of both remanufactured and new or virgin products has a direct influence on these products demand. Segmentation of customers is created by different price levels. Pricing is important factor in revenue management when both new products and remanufactured are concerned. When priced lower, the remanufactured products can secure demand from consumers who will not pay the amount for a new product but yet desire to acquire the greater value from the remanufactured forms of these products. Similarly, original products may be set a price greater, and revenues can be exploited from consumers willing to pay extra and recognize the higher priced virgin products as possessing superior quality. Some research where such facet is dealt with are Vorasayan and Ryan (2006), Ferrer and Swaminathan (2010), and Debo et al. (2006). What would the ideal costs be for the remanufactured or the virgin products? Several other issues impacting the pricing of finished products (remanufactured and new) are cannibalisation of demand between them and consumer behaviour towards remanufactured and new products. (Chakraborty et al., 2021).

Competition

Ferguson and Toktay (2009) analysed the optimum strategies of production in a competitive environment. Their outcomes present that the in-house production of the remanufactured products might need to be more profitable for the manufacturing firm. Further, the authors stated that the manufacturer considered in their study might still make remanufactured products to avert the 3P remanufacturers from contesting and pinching the segment of market, which may utterly cannibalise its income. In contrast, Atasu et al. (2008) studied the connection between optimum manufacture tactics for remanufactured products and their market size. Through the case study, the authors emphasized that there is an upper limit on the market size above which the manufacturers must employ in remanufacturing to maximise their profits.

Considering all five factors mentioned above, a manufacturing firm has to decide to engage in remanufacturing strategically. Manufacturing firms must decide whether to acquire remanufacturing facilities, equipment and technology or outsource the activity. This decision has been addressed in the literature and explained in the following section.

Quality of Returns

The used products that are procured may be of a different quality. Such differential effects the cost related with remanufacturing and is very significant for managing the revenues. Most firms separate the used products into various sets of cores. For example, returned products from retailers merely because of incorrect consignments have nothing inappropriate with the quality of produce and could be pushed as it is in the marketplace. Products with certain aesthetic problems like an abrasion need lesser cost and time to fetch them up to the resalable. There could be products that are tough to remanufacture due to substandard worth, and the cost concerned here is very high.

Outsource or In-House

Recently, numerous brands stores have started remanufacturing. In this case, Would OEMs subcontract their remanufacturing activity to their stores? To answer this question, Lin et al. (2024) analyzed two scenarios namely remanufacturing outsourcing strategy (ROS) and remanufacturing in-house strategy (RIS), with application of system dynamics, they found that RIS outperforms ROS system including less peak capacity cost, Qian et al. (2020) developed two models in which an OEM interacts with an autonomous store on remanufacturing operations with the choice to either subcontract remanufacturing to their store (Model R) or remanufacture all products in-house (Model M). The outcome displays that though model M actually expedites superior environmental, economic, and social sustainability, it has extra charges for the retailer. He et al. (2020) developed two models based on two scenarios where OEMs (1) commence remanufacturing in-house or (2) subcontract it to a contracted remanufacturer (CR). Their outcomes showed that to pose a lesser cannibalisation problem for new product sales, OEMs would probably choose an inferior product quality when subcontracting remanufacturing to a

CR. Further notably, from the economic viewpoint, it was found that outsourcing remanufacturing to a CR hampers the OEM and the industry. However, in-house remanufacturing is advantageous for OEM in terms of environment and economics. However, for the rest, despite cutting down the profit, outsourcing is equally or more environmental-friendly. Recently, outsourcing collection versus in-house in a CLSC with remanufacturing technology development has been studied by Chen et al. (2022). The authors compared the two scenarios using system dynamics modelling.

Ferrer and Swaminathan (2006) and Toffel (2004) showed that OEMs encounter numerous decisions between steering remanufacturing themselves and subcontracting remanufacturing to 3Ps. OEMs must take into account aspects of integrating vertically (or coalitions with competitors and multiparty ventures) instead of depending on autonomous firms when they may use implicit information and patented material attained while manufacturing, engineering, and design, to their goods reclamation operations. Integrating vertically is more appropriate if there is a risk of being over reliant on recollection entities for unique or rare modules.

Competitiveness

The application of the sustainable strategy plays a vital role in bettering the enterprises' competitiveness in a supply chain, which is well-intentioned of further matters in sustainable supply chain management. Ghosh et al. (2018) studied collaboration and competition among an OEM and a remanufacturer in the case of subscription-based contracts. Zheng et al. (2019) investigate the effects of DfE (design for environment) on companies' magnitude results and the effects of competition on the DfE decision in the instances that an independent remanufacturer (IR) and an original equipment manufacturer (OEM) are combined and a competitive instance in which IR and OEM are standalone. Most of the current research is grounded on the hypothesis that independent remanufacturers would harm the OEM. However, Wu and Zhou (2016) pose an remarkable outlook that contending OEMs with no remanufacturing capabilities occasionally gain from the entrance of third-party remanufacturers. These researchers are centred on the contest between the remanufacturer and the original manufacturer. Unlike above research, we consider the competition among original OEMs having remanufacturing capability (i.e., HMRS), and the OEMs having collection and remanufacturing activity outsourced to third party (i.e., R2M) and independent remanufacturer and OEM (i.e., M/R). These configurations are explained in detail in next section.

We observe that integrated models of factors still need to be explored in the literature to decide the best-suited configuration. Some researchers have tried to study the effects of pricing, competition and quality of returns to evaluate the configuration strategy. However, customers' participation from the willingness to pay for a remanufactured product and their trust in a remanufacture activity of operations still needs to be addressed, which is crucial for remanufacturing from a long-range point view. Customers are focused on remanufacturing as they are the source of used goods to be remanufactured and the destination for the remanufactured products. From the literature, it has been observed that to answer the research question of opting for the best-suited configuration, a conceptual framework is required to assist manufacturing firms in taking strategic decisions. This conceptual framework categorically classifies the factor variables into controllable, collaborative, and quantitative variables and their impact on configuration. The conceptual framework is elaborated in the following section.

Conceptual Framework

The conceptual framework aims to depict the role of factor variables in configuration strategy and their interrelation with other variables. Firstly we elaborate on the three configuration strategies based on their attributions. Three configurations of manufacturing and remanufacturing firms are considered for the study: HMRS, M/R, and R2M. Where HMRS is a Hybrid manufacturing and remanufacturing system, M/R represents manufacturer and remanufacturer are two different entities serving customer demand, and R2M represents that the remanufacturer only carries out disassembly activity and the manufacturer processes these subcomponents. These configurations are explained in detail in this section (Table 1).

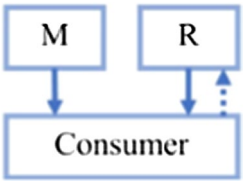
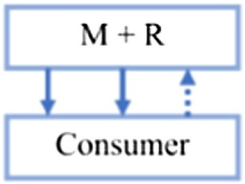
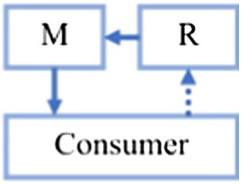
Manufacturing and Remanufacturing M/R

The manufacturing firm in this configuration option is not to acquire the remanufacturing. The manufacturing firm caters to customers' demand, and the remanufacturer caters to customers' demand separately. Remanufacturing firms carry out all necessary activities of remanufacturing and serving the customer. While manufacturing firm opts to serve the market with new product. Here, the competition is based on the pricing of products.

Remanufacturer to the Manufacturer R2M

In this configuration, the remanufacturer has to perform all activities up to the disassembly of the good into a module level and disposal of waste. The manufacturing facility supplies the component-level items as sub-assembly and raw materials. R2M is a collaborative model. A manufacturing firm outsources the remanufacturing activity to a remanufacturer with expertise in that domain. It responds to the

Table 1 Configurations under study M/R, HMRS and R2M

	Manufacturing/remanufacturing M/R	Hybrid manufacturing and remanufacturing HMRS	Remanufacturer to the manufacturer R2M
Stages of life cycle	Design, obtaining materials, manufacture, assembly, quality control	Design, obtaining materials, manufacture, quality control, assembly, reassembly, disassembly, sorting, cleaning, inspection, refurbishment,	Disassembly, categorization, refurbishment, cleaning, inspection, quality control, reassembly,
Patterns in input	Known quantity and quality	Mixed quality uncertainty in returns	Uncertain quality and quantity
Time to process	Fixed	variable	Highly variable
Volume of production	High volume/low volume		Often low volume
Patterns in output	Known quality and quantity	Known quality and quantity	Uncertain quality and quantity
Inventory cost	Often low cost	higher cost	High cost
Inventory planning approach	Market-driven approach	market-driven	Waste stream and market-driven approaches
Cost of production (per unit)	Higher	low	Low
Price of product	Higher	Low	Low
Man–machine production	Machine driven	Man–machine combination	Labour intensive
Industrial pollution	High pollution	less pollution	Less pollution
Investment	High investment	medium investment	Less investment
Economy model	Linear	Circular	Circular
			

customer's demands by utilizing the subassembly and raw material provided by the remanufacturer and their suppliers based on demand.

Hybrid Manufacturing and Remanufacturing HMRS

HMRS is the configuration where the manufacturing company engages in remanufacturing fully. The manufacturing firm acquires all the facilities and technology to perform remanufacturing. Production planning, returns management and demand management are key aspects of this configuration.

Controllable Variable Within the Control of the Firm

Ferrer and Swaminathan (2006) review the ideal manufacturing approaches of the remanufactured and new products for instances with multiple, or infinite-period forecasting. They exhibit that it is desirable to manufacture remanufactured products when the cost difference between cost the remanufactured and new is adequately high. Ferguson and Toktay (2009) investigate the optimum production policies in a competitive situation. They find that even when manufacturing the remanufactured products might not be cost-effective for the manufacturing firm, the manufacturing firm can still manufacture remanufactured products to avert the 3P remanufacturers from participating and pocketing the market share, which may completely cannibalise its profits.

Pricing management is one more significant topic in remanufacturing as it influences the cannibalisation among the sales of the remanufactured and virgin the products (Bulmuş et al. 2014). Manufacturing firms require distinct pricing approaches for the remanufactured and new products to maximize profit. The pricing policy also governs the availability of product.

Manufacturing firms can decide on the manufacturing and remanufacturing costs and their pricing based on maximising firms' profits. The process of minimising costs is within the control of the manufacturing firm.

Collaboration Variables Which can be Exercised Using Negotiations and Contracts

The rate of collection is a acute factor since the input of remanufacturing are used products. In reality, for manufacturers, the collection of end-of-life products is not believed a core capability and, so, often subcontracted. Nevertheless, several companies own started specific collection

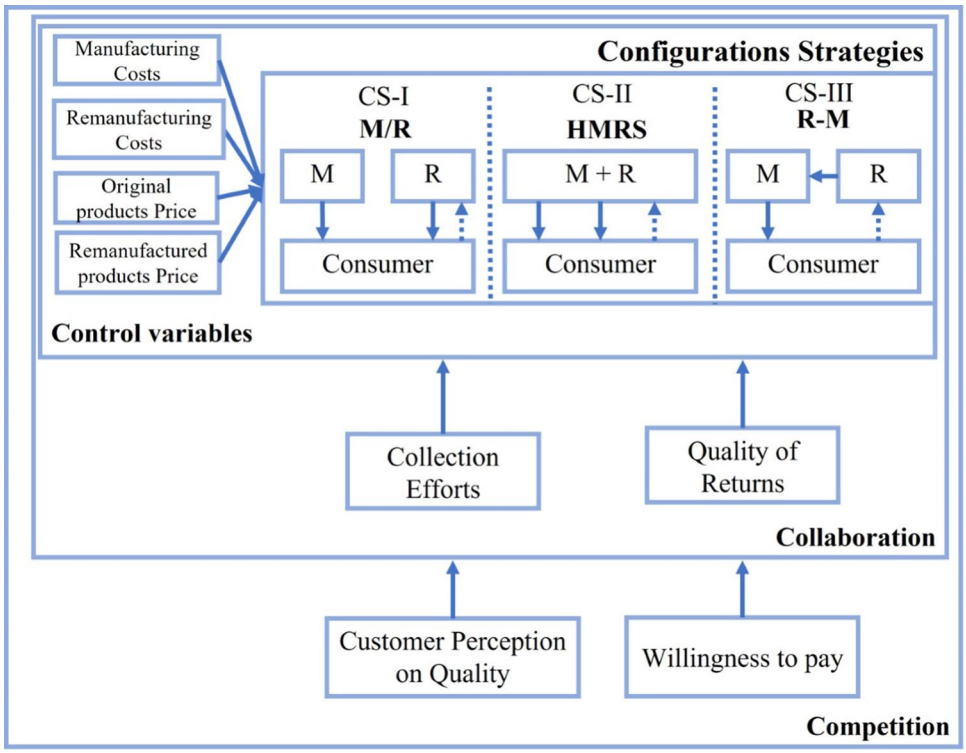


Fig. 2 A conceptual framework for configuration strategies

mechanism to manage their brand. These organizational resolutions lead to numerous supply-chain configurations, which affects the total remanufacturing costs.

Collection efforts made by the firm as well as the participation of customers to return used products. By providing lucrative incentives, customers' participation can be increased. Collection efforts of both manufacturer and customer will be enhanced. Collection efforts can be increased using the third-party intervention. Such third-party intervention may lead to a dual collecting channel competing with a single collecting channel, explained in R2M and HMRS. (Huang et al., 2013).

Competitive Variables Which win the Customers Through Perception and Trust

Willingness to Pay

Because of the many energy salvaging and material salvaging in the manufacturing operations, the remanufactured products have an added markdown benefit rivalled with the virgin products. For customers worried about price, produce with the identical quality maybe purchased at lesser prices, accordingly promoting the buying of remanufactured products (Bakal & Akcali, 2006).

Customer Perception of Quality

Although remanufacturing signposts that the quality of the remanufactured product is the identical as the new product, customers take note to the quality of the product and do not have faith in in the marketing of remanufactured products (Örsdemir et al., 2014). Quality concerns are expected to impact the willingness to pay for remanufactured goods.

The quality of remanufactured products manufactured OEM and independent remanufacturers (IR) differs. The difference in sellers, prices and brands affect customers' perception of the quality of remanufactured products (Abbey et al., 2015). Perceived quality may also affect customers' willingness to pay for remanufactured products (Sun et al., 2018).

The accessibility and lower cost of cores (the used products to be remanufactured), labour costs and transportation, the cost of new versus remanufactured goods, the availability of new alternatives at lower prices, and customer perceptions of price and quality are important factors affecting the competitiveness of remanufacturers in all sectors and markets (Fig. 2).[2]

This conceptual framework highlights all variables to formulate the configuration strategy for manufacturing firms. The manufacturing firms control the pricing and costs of

[2] https://www.rematec.com/news/industry-players-and-markets/remanufacturing-boosts-the-aftermarket-in-the-us.

the manufactured or remanufactured product. By leveraging these variables, manufacturing firms can adopt the best-suited configuration. Once a configuration strategy is selected, manufacturing firms must deal with the collaborative factors where the level of collection efforts and quality of returns are primary factors. Collaboration means profit-sharing contracts, buyback schemes and incentive schemes with customers or third-party collection firms. Lastly, manufacturing firms have to face competition with other manufacturing firms based on customers' choices and preferences. Customers' willingness to pay for the remanufactured product is a key factor for order winners. The perceived quality of the remanufactured product also significantly impacts customers' buying behaviour.

Illustrations

The three configurations are M/R, HMRS and R2M. To explain how these configurations perform in the given framework, we can take the toy industry in India as an example and observe the performance of each configuration. Various NGOs are participating in the collection of used toys, and using reuse, remanufacture, and refurbishment, these toys are brought back to the toy market. The toy life is very short, but the functional life is much more than the used life of the toy. You can take the example of pull back car toy. A child plays with the toy for at most a year or so, and then these toys are kept aside. However, the functional life of the spring inside the car, the body and wheels, is more than that of the year. These cars are refurbished or remanufactured by the toy manufacturer and brought back to the market. Impact of collaborative decision variables on configuration strategies. Collection effortAs collection effort increases, the performance of HMRS and R2M increases. Remanufacturing the collection of returned products requires the full participation of management in offering incentives, buy-back policies, and opening collection centres. For M/R, this collection effort does not impact the performance of the configuration as the remanufacturer takes responsibility for the collection and distribution of the remanufactured products. On the other hand, in HMRS and R2M configuration, the manufacturing firm is actively involved in collection activity. Quality of returns As the quality of returns increases, all three configurations perform well in the market. As per the configurations, the responsibility of inspection disassembly is clearly stated. In M/R, the remanufacturer will take responsibility for the quality checks and remanufacture accordingly. R2M remanufacturers act as collectors, disassemble to the subassembly or component level, and provide such semi-finished products to the manufacturer. HMRS configuration takes responsibility for quality as a single unit. Impact of competitive decision variables on configuration strategies.Customer perception of quality and willingness to pay Customers' behaviour is an uncontrollable variable for the manufacturing firm. Especially in the case of a remanufactured product, customers doubt the product quality when the manufacturing firm tags a remanufactured product with a label. It is imperative to create Customer awareness of the sustainability aspects of the manufacturing, assuring the quality with value to the customer. In the case of HMRS, the manufacturers must ensure the quality of remanufactured and virgin products is the same. Customers' participation in buy-back schemes will enhance their willingness to pay for the remanufactured products.

Conclusion

Remanufacturing as a domain is fast becoming a significant field as more laws come in to back it on one hand. On the other, the sheer economic necessities make it an absolute inevitability. However, when a firm heads in remanufacturing, management of revenue becomes very essential as there is rigorous competition in manufacturing. In remanufacturing, managing revenue becomes important not only to achieve a cost advantage over the competition but is thriving out to be a winner in profit maximisation strategy. The costing and pricing of the product are well within the control of the manufacturing firm. Based on customer expectations firm can position the product in the market preferable to their revenue structure.

Customers' enthusiasm to take part in returning products is a decisive basic step in collection efforts. Some studies have tried to comprehend consumer motives and return practices. Different customers have different opinions of the reliability of remanufactured products, which means that customers' willingness to pay for remanufactured goods is indefinate and lower than that for new goods. The production cost per unit of remanufactured products is generally lesser than that of new products; hence, the price of remanufactured items is lower. Consumers who are price sensitive may turn to remanufactured items, and therefore, the market demand tends to be subjective by the prices of the products. As a result, it is important to reflect consumer willingness to pay when product prices are determined. Competition is inevitable at the marketing stage of remanufactured products because of the simultaneous existence of new and remanufactured products on the market.

The rising demand for increasing asset utilisation in manufacturing industries notably drives the remanufacturing market growth. However, factors like the low-cost competitive pricing strategy may impede manufacturers' market growth in developing countries. The global remanufacturing industry market is still small, and quite a few companies are involved in remanufacturing operations, but the types of

products appropriate for remanufacturing and their demands are increasing every year.[3]

Our research attempts to map the consumer behaviour with pricing and quality-related issues with configuration of manufacturing strategy. Further, this research focuses on the cost and pricing decisions that affect the manufacturing firm to opt for the best-suited configuration. These manufactured and remanufactured products serve the same market. Collecting effort plays a crucial part in the success of hybrid manufacturing and remanufacturing systems. Customer participation and third-party involvement in returns management help manufacturing firms adopt hybrid manufacturing and remanufacturing system. Lastly, from the buying behaviour perspective, consumer's' perception of a remanufactured product and their willingness to pay for remanufactured products play key roles in the configuration system. However, this study can be extended by considering the competition among primary and secondary markets based on configuration.

This conceptual framework will help manufacturing firms adopt the best-suited configuration and offer a decision-making framework for the variables within control and collaborative factors. The competitive advantage is gained by manufacturing firms adopting remanufacturing or hybrid manufacturing and remanufacturing system.

Although this paper attempts to guide business firms in making configuration decisions for their business, some of the areas still need to be investigated. How could a firm market its remanufactured product? Marketing plays a pivotal role in showcasing the product with its features and functionalities. Marketing and manufacturing are two pillars of the business. One should investigate their interrelationship in the context of remanufacturing.

Secondly, researchers may fill the gap by advancing this study in pricing and costing parameters. As per the definition of remanufacturing, "the remanufactured product is *as good as* new". However, in real life, customers are not willing to buy the remanufactured product at the same price as the new one.

Key Questions Reflecting Applicability in Real Life

1. What is the relationship between controllable and collaborative variables? Pricing and costing are considered controlled variables, and collection efforts and quality of returns are collaborative variables.
2. How does the market structure in which a firm operates affect the penetration of remanufactured products?
3. How does a firm gain a competitive advantage by collaboration and active participation of customers to imbibe sustainable manufacturing practices?

[3] https://www.technavio.com/report/industrial-machinery-remanufacturing-market-industry-analysis.

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Declarations

Conflict of interest The authors declare that there is no a known conflict financial interest or personal relationship that could have influenced the study. The authors have no relevant financial or non-financial interests to disclose.

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