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## Marketing issues for remanufactured products

### Abstract

Remanufacturing is an industrial process whereby used products are restored to useful life. This special issue seeks to address marketing issues for remanufactured products and provide an in-depth understanding of their barriers, together with mitigating practices and future opportunities. The articles present and analyse opportunities to improve marketing approaches for remanufactured products through exploring various marketing strategies, consumer behaviours, pricing and branding decisions, and optimized green transportation. This editorial note summarizes the outcomes of the papers published under this special issue, in addition to discussions on various influencing factors on marketing issues for remanufactured products including marketing attributes, customer willingness, pricing practices and performance evaluation methods. The final conclusion shows that there is sufficient scope to explore various perspectives connected with the issues of marketing remanufactured products through different fields of application.

Keywords: Marketing issues; remanufactured products; consumer behaviour; pricing and branding

### 1. Introduction

Remanufacturing is an industrial process whereby used products are restored to useful life (Wei et al., 2015). This concept has recently gained significant importance because of increased awareness by corporate leaders and improving government regulations (Subramoniam et al., 2010; Govindan et al., 2016; Li et al., 2018). In recent decades, many companies have developed environmentally-conscious policies and procedures related to product design, manufacturing and distribution operations, and end-of-life product management by implementing, among other measures, end-of-life strategies to recover value from used products (Flapper et al., 2006; Sun et al., 2013; Xia et al., 2015). Remanufacturing is one of these end-of-life strategies that can be considered not only as a way of complying with legislation, but also as a business opportunity with a high impact on the economy (Guide and Van Wassenhove, 2001; Linton, 2008; Subramoniam et al., 2013). In this sense, remanufacturing can be considered to be one of the more attractive strategies for sustainable environments (Sharma et al., 2010; Sasikumar et al., 2010).

Many topics related to remanufacturing have been investigated in several fields and from different points of view: from product acquisition for remanufacturing (see Wei et al., 2015 for a review), through design for remanufacture (Hatcher et al., 2011 provide a complete review), to inventory and production planning in the remanufacturing environment (see, for example, Vercraene et al., 2014; Junior and Filho, 2012) and marketing considerations for remanufactured products (Subramanian and Subramanyam, 2012; Jiménez-Parra et al., 2014). However, the role of remanufacturing as an effective way to contribute to sustainability still constitutes a research challenge.

According to Tukker et al. (2006), sustainable consumption focuses on formulating strategies that foster the highest quality of life, the efficient use of natural resources, and the effective satisfaction of human needs while simultaneously promoting equitable social development, economic competitiveness, and technological innovation. In this sense, the link between remanufacturing and sustainable consumption deserves closer attention, in order to investigate whether remanufacturing substantially reduces the environmental impact by analysing the role played by the consumers of remanufactured products.

While processes involved in remanufacturing industrial products have been discussed for many years, research examining consumers, markets and, perceptions of remanufactured products has been scarce (Abbey et al., 2015a; Jiménez-Parra et al., 2014; Michaud and Llerena, 2011). A more comprehensive understanding of the marketing issues for remanufactured products is needed (Souza, 2013; Sinha et al., 2017), so that the relationships between consumers and these markets may be more effectively analysed (Atasu et al., 2010; Govindan et al., 2015; Subramanian and Subramanyam, 2012).

In this context, this special issue (SI) for the Journal of Cleaner Production is open to a wide range of topics analysing marketing issues for remanufactured products, including:

- Marketing strategies for remanufactured products
- The consumer behaviour of remanufactured products
- Their willingness to pay
- Their purchase intention

Although there are some works in the existing literature that recognize the necessity of analysing *marketing aspects for remanufactured products* (Guide and Van Wassenhove, 2009; Atasu et al., 2010) and/or partially study these issues (Michaud and Llerena, 2011; Saavedra et al., 2013), more research on this topic is needed. More specifically, some of the peculiarities of remanufactured products render it advisable that sellers adapt their commercialization strategies for these kinds of products. Regarding the *consumer behaviour of remanufactured products*, there exists a traditional classification of different market segments based on their interest in the purchase of these products: green consumers, functionality-oriented consumers and newness-conscious consumers (Atasu et al., 2010; Wang et al., 2013; Jiménez-Parra et al., 2014).

However, recently, Abbey et al. (2015a) proposed another classification made up of two consumer segments: (1) *consumers relatively indifferent between original and remanufactured products, who display high sensitivity to price discounts* and (2) *consumers who show strong preferences for original products (with an accompanying aversion to remanufactured ones) and relatively low sensitivity to price discounts*. More research is expected to provide further knowledge about how to characterize potential consumers for remanufactured products in order to establish a more adequate commercialization strategy for these products. According to recent studies (Michaud and Llerena, 2011; Hazen et al., 2012), *consumers' willingness to pay (WTP)* for remanufactured products is lower than their WTP for original ones. In this sense, more research should be focused on discussing about how to improve the WTP for remanufactured products, and subsequently, to increase the consumers' willingness to purchase them. Finally, regarding the *purchase intention for remanufactured products (PI)*, literature seems to confirm the influence of several supply factors on PI, such as seller reputation, remanufacturer identity (original equipment manufacturer (OEM) vs. third product remanufactured (3PR)) or marketing stimulus (Subramanian and Subramanyam, 2012; Jiménez-Parra et al., 2014). Similarly, the influence of some demand factors, such as consumer attitude and consumers' social referents, was described in the electronics sector, automobile spare parts market, and other sectors (Wang et al., 2013; Gaur et al., 2015). However, in order to advance our understanding with regard to the PI of remanufactured products, more research is needed (Gaur et al., 2015), particularly in order to

describe and analyse the relationship between remanufactured products and sustainable consumption.

Therefore, for this SI, a team of Guest Editors (GEs) warmly invited authors to submit research and/or review papers that address the topics in Table 1. Authors were encouraged to submit studies within four broad categories, *'Macro Research Areas'* and to address one or more *'Topics'*, in an integrated, multi-disciplinary paper designed to provide insights about the present and likely future directions of sustainable consumption through remanufacturing.

From the number of submissions received, the Editors selected nine papers for publication in this Special Issue based on their quality, novelty, and the new insights into remanufacturing that they provided. In general, this SI combines the process of considering both theoretical and empirical evidence with the focus of motivating the marketing of remanufactured products through addressing their respective issues. Based on the outlook obtained from the theoretical perspective, this SI helps to develop a deeper understanding of remanufactured products and of the empirical evidence that seeks to justify the challenges involved, together with their respective mitigation practices, including improving marketing strategies, understanding consumer behaviour, pricing and branding techniques, and optimized transportation of remanufactured products. The editorial note is structured as follows. The first section deals with the introduction of the editorial note and the importance of this SI and how this SI is different from the existing literature. This is accompanied by a brief literature review with various classifications, and detailed analysis on the top 20 cited papers. In the next section, selected articles in this special issue are summarized briefly in order to understand the value created by this SI. This section classifies the accepted articles into five subsections: namely, marketing strategies for remanufactured products, consumer behaviour of remanufactured products, pricing and branding for remanufactured products, green transportation for remanufactured products, together with implications. The final section takes some learning points from this SI.

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## 2. Literature on remanufacturing

In order to increase the existing knowledge in the research area under consideration, documentation containing a collection of papers published in the area of 'Remanufacturing' has been created. In this section, the Scopus databases were accessed. The search term includes the macro research areas, namely remanufacturing with marketing strategy, consumer behaviour, willingness to pay and purchase intention. The search period used was from 1988 to 24 Feb 2018. Fig. 1 shows the number of documents (articles) published over the years with regard to remanufacturing.

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The document types of the collected papers were explored with the assistance of additional investigation in Scopus. However, in order to improve the reliability of the documents concerned, some of the document types (conference papers, notebook chapters, books, and short surveys) were excluded from this search. Considering this exclusion criteria, a total of 156 documents were considered. These include articles and reviews published under the theme of remanufacturing (shown in Fig. 2).

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As well as the document type, the contribution of each country towards the remanufacturing research was identified and Fig. 3 shows the top ten countries in terms of contribution in the research area concerned. This contribution is based on the author's country of origin, according to which most documents (65) were published by China, 55 by the United States, 15 by the United Kingdom, 13 by Hong Kong and 12 by Taiwan.

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In order to explore the top published documents, this review ended by summarizing the list of the top 20 cited articles (shown in Table 2) published on the topic of remanufacturing. Finally, it can be understood from the literature survey that the trend in considering remanufacturing has increased in recent years. Hence, this may well be the right time to give remanufacturing a boost by addressing its marketing issues, thus rendering this SI relevant and timely for the authors and readers of the Journal of Cleaner Production.

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### *2.1. Recent trends in remanufacturing*

This subsection discusses the recent research trends in remanufacturing by exploring the literature published since 2016. To explore the recent trend, the following key terms are applied in Scopus: “TITLE-ABS-KEY (remanufacturing) AND (LIMIT-TO ( PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) ) AND (LIMIT-TO ( EXACTKEYWORD, "Remanufacturing") ) AND (LIMIT-TO ( DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re") ) AND (LIMIT-TO ( LANGUAGE, "English"))). In this review, we found that most of the remanufacturing articles published between 2016 and 2018 focus on specific areas which include pricing decisions, warranty policies, customer behaviour/willingness to pay for remanufactured products and the supply chain, including the closed supply chain system. Few studies focus on the engineering applications of remanufacturing such as design for remanufacturing, remanufacturability-based material selection and processing, life cycle assessment for remanufactured products, etc. Some studies also consider the environmental impacts of remanufactured products by assessing their emission levels. However, only three papers (Yazdian et al., 2017; Xiong and Yan, 2016; Wang and Kuah, 2018) have been published on the theme of the marketing of remanufactured products. Despite raising awareness about problems encountered in the marketing of remanufactured products, very little attention has been paid to this issue. This evidence proves that there is still sufficient scope to deal with the issues that exist in the marketing of remanufactured products. In this connection, this SI can bridge the gap between the literature and help to address the various issues involved in the marketing of remanufactured products.

## **3. Marketing issues for remanufacturing products**

This section discusses the marketing challenges of remanufactured products and provides solutions for overcoming those challenges through marketing strategies, understanding consumer attitudes and preferences, expertise in pricing and branding, and through optimized green transportation. Furthermore, the implications of the proposed solutions are discussed in detail.

### *3.1. Marketing strategies for remanufactured products*

There are many issues involved in the marketing of remanufactured products, but the major barrier facing the marketing of remanufactured products is the customer's perception towards their

quality (Tebourbi and Khemakhem, 2017). With this in mind, many studies sought to devise various solutions by integrating strategies including incentives, awareness education, etc. Alqahtani and Gupta (2017) considered the remanufactured product warranty as a key for marketing remanufactured products. The effect of offering a warranty on remanufactured items was quantitatively assessed. The remanufacturer obtains sales and the buyer is attracted by the appealing price and is more confident in the product's quality as a result of the warranty. Furthermore, this study scrutinizes the impact of offering renewing warranties on remanufactured products, with the particular focus on minimizing the cost and maximizing consumer confidence in buying remanufactured products. The proposed Advanced Remanufacturing-To-Order (ARTO) system is shown in Fig. 4 to identify an ideal implementation of a 2D renewing warranty policy for remanufactured products.

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Another major constraint for marketing remanufactured products is market fluctuation. Hence, Zhao and Zhu (2018) proposed a strategy that satisfies the need to reduce the risk of stock shortages under heavy remanufacturing market fluctuation, calling this a 'risk-averse marketing strategy.' This proposed strategy developed coordination mechanisms that cover multiple practical issues at the same time. Some of those issues include the remarketing issue relating to the issue of shortages and lost sales, the issue of supply chain coordination between an end-of-life product collector (retailer) and a remanufacturer relating to lack of contract regulation, and the issue of uncertainties relating to fluctuating demand and the remanufacturability rate. For validation, this proposed strategy was back-tested, using the case of a remanufactured truck engine. In recent years, various products have been remanufactured in order to restore value, as remanufactured auto parts have a long history. The studies show that most Asian remanufacturing markets are in the very early stages of development and they face many issues when marketing remanufactured auto parts (RAPs). Hence, there is a need to explore these Asian RAP markets in order to promote and develop new marketing strategies. With this in mind, Matsumoto et al. (2018) reviewed the history and factors affecting the green purchasing behaviour with regard to RAPs in Japan. For this study, an Internet survey of 500 Japanese and 473 US respondents was conducted to explore the factors influencing purchase intention among Japanese customers. In addition to the review, the transition of the Japanese RAP market and their consumers' perception were analysed. The study concludes that consumers' product knowledge, perceived benefits, perceived risk, and price consciousness are the four factors which have a significant influence on the intention to purchase RAPs both in the US and Japan. Together with other problems, many industries have begun to face challenges around governing the supply chain in order to achieve supply chain coordination with retailers under extended producer responsibility (EPR) in remanufactured product marketing. Hence, there is need to look at this issue in more detail in order to promote governance in the remanufactured product market. In this regard, Zhao et al. (2017) proposed a mathematical model for remanufactured product marketing through the lenses of the Nash and Stackelberg game theory and the theories of sustainable supply chain governance (SSCG) and EPR. The proposed model was validated with Caterpillar® (CAT), which is a benchmark producer that markets remanufactured products successfully.

### *3.1.1. Implications*

- Alqahtani and Gupta (2017) proposed a system which allows the remanufacturer to avoid unnecessary costs by enabling the remanufacturer to control the number of claims during warranty periods, and to determine which appropriate preventative maintenance (PM) policy to employ, using implanted sensors during the initial production stage.
- Zhao and Zhu (2018) proposed a risk-averse marketing strategy to help the remanufacturers and retailers to consider fluctuating risk in the market. This proposed strategy serves as a

hybrid objective marketing strategy concerning profit variations and economic gain, and it would be appropriate for remanufacturing practitioners. In addition, this strategy helps to demonstrate the need for contract regulation and it offers contractual conditions for remanufacturing practitioners.

- Matsumoto et al. (2018) reviewed the influential factors of the RAP market in Japan and the US. This study helps the Japanese market to be aware of RAPs, although 80% of Japanese consumers have never heard of RAPs. Primarily, this study outlines the importance of enhancing the consumer's view of RAPs with regard to the perceived benefits of RAPs, which would improve the marketing of RAPs.
- Zhao et al. (2017) characterized three marketing decision models with EPR, namely, the weakly dependent decentralized marketing decision, the strongly dependent decentralized marketing decision and the strongly dependent collaborative marketing decision, which helps the company to take decisions. In addition, this study helps case managers to identify the factors that influence sustainable collaborative marketing governance mechanisms, namely social relations and sustainable product design.

### *3.2. The consumer attitude and preferences towards remanufactured products*

Customer behaviour and preferences are always important keys for promoting remanufacturing product markets. Quality serves as the most pressing factor from the customer's perspective (Sharma et al., 2010) when buying a remanufactured product. Hence, several attempts have been made to improve the quality of the remanufactured product. Selecting an optimal remanufacturing quality strategy (RQS) for balancing profit and quality is considered a tedious process. With this in mind, Cui et al. (2017) developed a comprehensive model (shown in Fig. 5) that provides precise guidelines for remanufacturers by selecting an optimal RQS based on customer preferences (CPs). For this study, three types of preferences were considered whereby the relationship between quality, cost, and demand functions were explored.

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Insert Figure 5 here

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In addition to exploring customer preferences, Bai et al. (2018) studied the consumer's attitudes and behaviour towards recycling products with a particular focus on smartphones. For this study, the Chinese recycling context was reviewed in order to explore the pattern and trends of Chinese customers' attitudes and behaviour. For this, the survey was conducted on 5 tier-one cities, 21 tier-two cities, and 45 tier-three and lower cities; one-third of the samples came from each sub-region. Furthermore, the data was analysed using IBM SPSS Statistics 22.

#### *3.2.1. Implications*

- Cui et al. (2017) proposed a model which offers precise guidelines for remanufacturers to resolve the dilemma of selecting an optimal RQS and simultaneously achieving cost, quality, profit and customer goals.
- From the study conducted by Bai et al. (2018), several implications were drawn which include the following: i) this study suggested that information security is the factor that has the greatest influence on recycling decisions, by which it can be determined that trust is key for competitive success, and ii) customers expect to have door to door recycling services provided, so recycling industries can plan their servitization strategies accordingly.

### **3.3. Pricing and branding for remanufactured products**

It is well known that the remanufacturing sector faces important challenges with regard to pricing (Tukker et al., 2006) and branding for remanufactured products. Most remanufactured products are not supported by significant branding investments and market programmes. Hence, many

studies attempt to improve the branding and pricing for remanufactured products. Choi (2017) studied the optimal pricing and branding of remanufactured fashion products, an industry for which existing studies are limited. In order to explore the considered objective, this study features a fashion retailer who creates remanufactured fashion products from collected used clothing and who then sells this clothing in the marketplace. Secondly, Bhattacharya et al. (2018) proposed a nonlinear unconstrained model with the objective of maximizing the profitability of a closed-loop supply chain (including remanufactured products) given a price-dependent demand. The variables considered for this study include sales price, acquisition prices for stages, total return percentage to be accepted, and their distribution.

### *3.3.1. Implications*

- Choi (2017) studied remanufactured products from the fashion industry. His study provides many useful implications with multiple perspectives including price, branding, government and supply chain coordination.
- Bhattacharya et al. (2018) studied the differences between a closed-loop supply chain and a forward supply chain given a price-dependent demand. From this knowledge, managers were able to get an idea of the optimum acquisition prices that they needed to pay for the collection of graded products in order to maximize their profit. Also, they were able to estimate beforehand the combination of used graded material expected to arrive at the premises and plan accordingly for efficient capacity planning processes with regard to operations in reverse chain centres.

## **3.4. Sustainable transportation for remanufactured products**

Increasing transportation costs are becoming a serious concern for many business organizations, especially those who deal with remanufactured products, because their price is typically lower than that of virgin products. Hence, many studies started to explore the effective transportation vehicle routing problem (VRP) with various objectives. Sustainability integration in transportation makes exploration of the VRP challenging for researchers. Soleimani et al. (2018) proposed a multi-objective non-linear programming model for the green vehicle routing problem (GVRP), including the distribution (both delivery and pickup) of end-of-life (EOL) products, both original and remanufactured. In order to achieve the considered aim, this study sought to minimize greenhouse gas emissions and total distribution costs through a proposed non-linear model. The same objective was validated through GAMS IDE/Cplex by applying a real-life case study. The proposed numerical model performs positively on both considered objective functions, which were capable of making reductions of almost 10.5% (cost) and 12.5% (green issues), respectively.

### *3.4.1. Implications*

- Soleimani et al. (2018) proposed a vehicle routing problem model which has more potential than the existing models and even includes sustainable preferences, whereby managers can enhance their remanufacturing system with less cost and more attention to green issues.

## **4. Findings and opportunities**

One of the main findings of this SI is that Asian markets face greater challenges than other markets when marketing remanufactured products. Another alarming fact is that 80% of Japanese people have never heard of RAPs, although the RAP market has existed in Japan for over two decades; this lack of awareness indicates that there is substantial scope for better communication on remanufactured products. Regarding price and brand functions, optimal pricing and branding investments will be higher for remanufactured products with a high base demand. There is always a relationship between supply chain and remanufacturing, and from the above studies we note

that the profitability of Closed-Loop Supply Chain (CLSC) increases with remanufacturing rather than with none (Chaudhary et al., 2017). This SI finds various solutions in order to motivate consumers to buy remanufactured products. For example, Bai et al. (2018) states that trust is the key factor when it comes to consumers choosing remanufactured products. The objective of this SI is to reinforce state-of-the-art scholarship in order to prompt even more research on the issue of concern, an issue that still contains considerable opportunities. Hence, in addition to the considerable findings, there are numerous opportunities within the remanufacturing research field, particularly in relation to the marketing focus, as discussed below.

- There is ample opportunity to assess risk in remanufacturing markets. Future studies may wish to investigate how multiple remanufacturers and multiple retailers conduct their coordination activities. In addition, there is sufficient opportunity to study other risk measurements for risk-averse remanufacturers or collectors of end-of-life products.
- Asian markets are facing significant barriers with regard to the marketing of remanufactured products when compared to other nations. The SI establishes that customers' perceptions in relation to remanufactured products are not always clear. Hence, there is opportunity to improve consumer willingness to buy remanufactured products, especially with a focus on the Asian auto parts markets.
- Sustainable supply chain governance mainly depends on the nation and level of the company. Therefore, there is sufficient scope to explore the transnational supply chain structure as a sustainable governance factor in marketing for remanufactured products. Exploring the impact of government and NGOs in the sustainable supply governance of remanufactured products is a meaningful area for future research.
- Transportation costs play a major role in the marketing of remanufactured products, and there is therefore sufficient scope to explore the vehicle routing problem effectively by focusing on sustainable and green strategies. For example, network analysis can be applied to this vehicle routing problem and objective functions considered, including distribution costs, green issues, and profit maximization of second-hand products. This will ultimately minimize the runtime and efficiency of the distribution system, but also closes the gap between theoretical models and practical considerations of distribution systems.
- Cost, profit, and demand functions are used to select the optimal RQS based on customer preferences, although existing studies are limited by fixed profit whereas in real life situations this profit varies. Hence, there is a possibility to understand the relationship between quality and profit based on the variable price.
- A CLSC of remanufactured products opens up many new areas for future research, which include analysing the distribution acquisition prices in multistage closed-loop remanufacturing. In addition, it is an interesting extension to explore the multistage closed-loop with varying quality conditions.
- In recent years, multi-stakeholder perspectives combined with sustainable supplier selection (Kannan, 2018; Kannan et al., 2014), sustainable manufacturing practices (Shankar et al., 2017) and third-party reverse logistics (Li et al., 2018) have captured everyone's attention, and these practices and strategies can be similarly applied for remanufacturing products.

## **5. Conclusion**

This Special Issue, “Marketing Issues for Remanufactured Products,” has summarized the hidden opportunities, barriers, motivating factors, methods and practices to enhance the marketing of remanufactured products. Useful findings are highlighted in order to improve the literature perspective on insights into remanufacturing with evidence relating to its marketing. Furthermore, these insights are able to give policymakers a clear idea of ways in which they can improve the branding of remanufactured products and can also help them to formulate more appropriate policies on promoting and implementing remanufacturing with the focus on marketing. Several factors on the marketing issues for remanufactured products were identified and discussed, in

which most of the studies show that the lack of consumer enthusiasm for remanufactured products is a key barrier in the marketing of remanufactured products. However, this SI provides innovative ideas together with some feasible solutions including future opportunities that exist for many marketing issues of remanufactured products and, in addition, it offers multiple perspectives and address all corporate levels.

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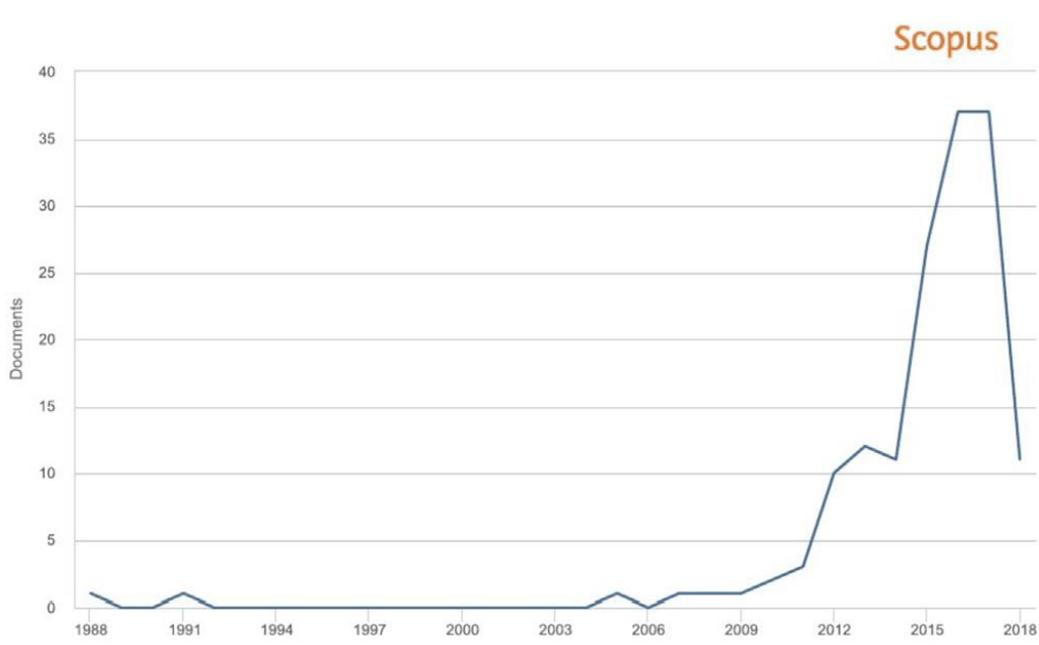
**Table 1. Research macro areas and topics**

<i>Macro Research Areas</i>	<i>Topics</i>
<p><b>Marketing strategies for promoting remanufactured product consumption</b></p>	<p><b><i>Product policy:</i></b></p> <ul style="list-style-type: none"> <li>• Design of remanufacturable products as part of the business strategy of an organization and main factors to be taken into account.</li> <li>• Type of warranty systems for remanufactured products to be performed in order to reduce the consumer’s uncertainty about them (quality, performance, functionality, etc.).</li> <li>• Brand strategies more adequate for the commercialization of remanufactured products.</li> <li>• Implementation of product service systems in B2C markets and main barriers that enterprises face.</li> <li>• Type of product positioning strategy more suitable for remanufactured products and main factors to be bear in mind.</li> </ul> <p><b><i>Price policy:</i></b></p> <ul style="list-style-type: none"> <li>• In addition to factors traditionally studied in the literature (seller reputation, type of remanufacturer, remanufacturing/commercialization costs, etc.), factors to be considered in the development of price strategies for remanufactured products (incentive schemes, taxes, rebates).</li> <li>• Effect of the ‘category’ of product on the price fixing for remanufactured products and the importance of this effect.</li> <li>• From a demand point of view, the role played by factors such as the type of consumer (industrial vs. final), the consumer willingness to pay or the perceptions of consumers about remanufactured products in the planning of price strategies.</li> </ul> <p><b><i>Distribution policy:</i></b></p> <ul style="list-style-type: none"> <li>• Type of channels (direct or indirect, offline or online) more appropriate to distribute remanufactured products and specific scenarios or circumstances more suitable for this distribution.</li> <li>• Possibility of sharing the same channels to distribute remanufactured and original products.</li> <li>• Management of design and implementation of logistics activities (collection, transportation, packaging, labelling, etc.) for remanufactured products: in conjunction with the activities of original products versus separately.</li> </ul> <p><b><i>Promotion policy:</i></b></p> <ul style="list-style-type: none"> <li>• Type of promotion strategies to be developed in order to reduce consumer’s uncertainty about quality, functionality and/or performance of remanufactured products.</li> <li>• Change of consumers’ (negative) perceptions about these products by using communication activities.</li> <li>• Adaptation of promotional campaigns to different segments of consumers of remanufactured products.</li> <li>• The role that government and other public institutions can/must play in the promotion of remanufactured products.</li> </ul>
<p><b>Consumer behavior of remanufactured products</b></p>	<ul style="list-style-type: none"> <li>• Main motivations of consumers to buy remanufactured products.</li> <li>• Effects of different factors (product category, complexity of purchase and presence -or not- of other products alternatives, etc.) on these motivations.</li> </ul>

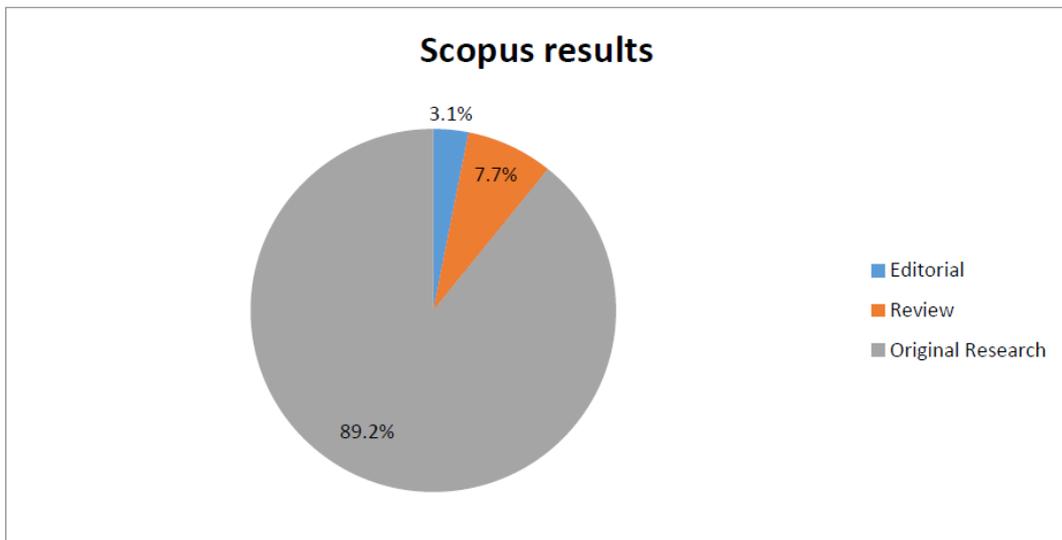
	<ul style="list-style-type: none"> <li>• Other factors (gender, level of income, level of education, etc.) to characterize the profile of potential consumer of remanufactured products.</li> </ul>
<b>Willingness to pay for remanufactured products (WTP)</b>	<ul style="list-style-type: none"> <li>• Influence of product's category/type on the consumer's lower WTP for remanufactured products.</li> <li>• Other type of factors which can affect the WTP for remanufactured products.</li> <li>• Influence of the type of information about remanufactured product provided by sellers and the quality of this information on the consumer's WTP for remanufactured products.</li> </ul>
<b>Purchase intention (PI) for remanufactured products</b>	<ul style="list-style-type: none"> <li>• Influence of the consumer's personal characteristics (gender, level of income, country of origin or level of education) on this PI.</li> <li>• PI for remanufactured products as predictive variable of the purchase of these products.</li> <li>• Possibility that PI might be product specific.</li> <li>• Models or theories to be employed to explain the consumer's PI of remanufactured products.</li> </ul>

Source: Jimenez-Parra (2014)

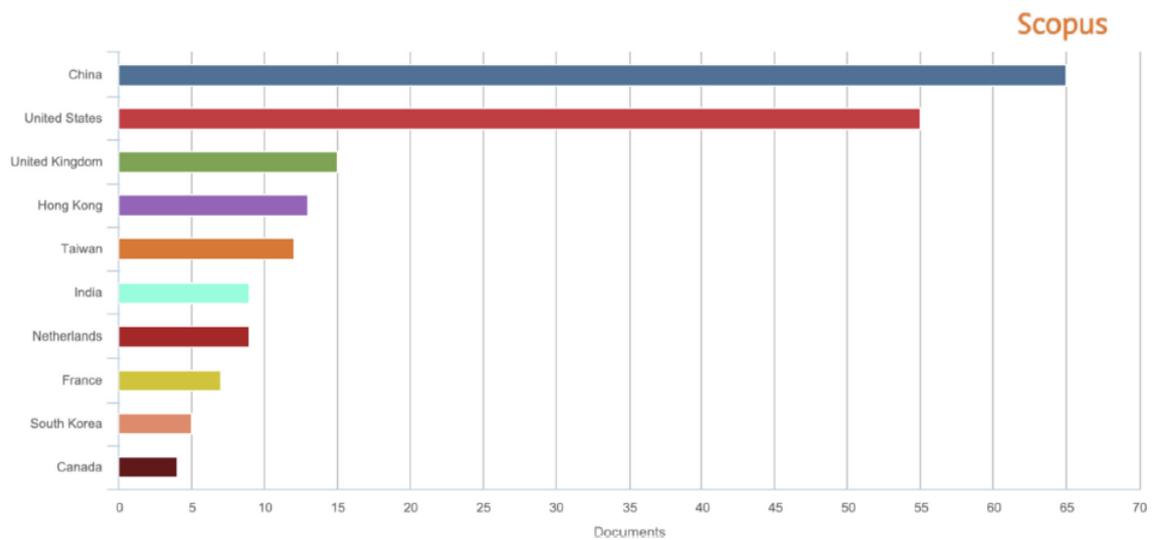
**Figure 1. Number of remanufacturing papers published in various time periods (1998- Feb 2018) as revealed in Scopus**



**Figure 2. Percentage share of different document types of journal articles as revealed in Scoups**



**Figure 3. Share of country of origin publishing remanufacturing topics as revealed in Scopus**



**Table 2. Overview on top 20 cited papers on remanufacturing**

S. No	Name of article	Authors	Article type	Problem addressed	Methodology used	Scopus Citation
1	Remanufacturing as marketing strategy	Atasu et al. (2008)	Conceptual and Modelling	Suggests guidelines to improve decisions on remanufacturing from the perspective of manufacturer. These suggestions are made on five key characteristics including low cost, lower valuation, green image, cannibalization of new products and supply constraints.	Monopolist model	287
2	The economics of remanufacturing under limited component durability and finite product life cycles	Geyer et al. (2007)	Modelling	Proposes strategic heuristic model which seeks to investigate the economics of remanufacturing by analysing the constraints (collection rate, durability and life cycle) involved in the remanufacturing supply loop.		150
3	The potential for cannibalization of new product sales by remanufactured products	Guide and Li (2010)	Empirical	Proposes an auction strategy with the assistance of Robert Bosch Tools, Cisco Systems Inc and NA. This strategy is applied in this study to explore the customer's behaviour and willingness towards the remanufactured products, which is also compared with their behaviour towards new products in order to improve the understanding of the belief that remanufactured products will cannibalize the original products. The consumers' willingness to pay (WTP) for both new and remanufactured products through auctions.	Real online auctions	116
4	Optimal prices and trade-in rebates for durable, remanufactured products	Ray et al. (2005)	Modelling	Analyses the optimal pricing and resulting trade-in rebates using an analytical illustration. This studies three different conditions for assessing the optimal price of remanufactured products, including uniform price, agedependent price, and age-independent price.	Numerical study	115
5	So what if remanufacturing cannibalizes my new product sales?	Atasu et al. (2010)	Conceptual	Describes the details about remanufacturing, especially their sales over time. Also gives details of market composition, cannibalization risk, supply constraints and life cycle effects.		90
6	Price and service competition between new and remanufactured product in a two-echelon supply chain	Wu (2012a)	Modelling	Considers the remanufacturing supply chain involving two manufacturers and a retailer. However, this study discusses the price and service competition that exists between new and remanufactured products, considering four different constraints, namely price and service competition, priceonly		72

				competition, service-only competition and absence of both.		
7	Revenue and cost management for remanufactured products	Ovchinnikov (2011)	Conceptual and Modelling	Discusses the novel inverted U-shaped customer behaviour pattern for remanufactured products, focusing on demand cannibalization and pricing strategy.	Case study	69
8	Product-design and pricing strategies with remanufacturing	Wu (2012b)	Modelling	Develops a two-period pricing regime for remanufactured products in order to efficiently manage the product design and pricing strategies.		63
9	Key factors in the market for remanufactured products	Subramanian and Subramanyam (2012)	Empirical	Examines the relationship between the purchase price of remanufactured products and virgin products by analysing the price driver differentials.	Regression analysis	60
10	The co-operative strategy of a closed-loop supply chain with remanufacturing	Chen and Chang (2012)	Modelling	Proposes an analytical model to investigate the competitiveness of remanufacturing compared with the original equipment manufacturer (OEM), from the perspective of a closed-loop supply chain. This study addresses the key question from the perspective of the OEM of “whether or not to participate in remanufacturing”.	Numerical study	60
11	Green consumer behaviour: An experimental analysis of willingness to pay for remanufactured products	Michaud and Llerena (2011)	Empirical	Identifies the willingness of customers to pay for green remanufactured products. This study uses the case of a remanufactured single-use camera to illustrate and explain this perception.	Experimental auctions	58
12	OEM product design in a price competition with remanufactured product	Wu (2013)	Modelling	Investigates two different dimensions of remanufacturing including competitive pricing and OEM product design, focusing on interchangeability levels with the help of the proposed model. .		54
13	The role of ambiguity tolerance in consumer perception of remanufactured products	Hazen et al. (2012)	Empirical	Examines the remanufactured product’s ambiguity tolerance and details the correlation between the willingness to pay and quality, with the help of structural equation modelling.	Structural model	54
14	Competition for cores in remanufacturing	Bulmus et al., (2014)	Modelling	Analyses the core of competition that exists between the OEMs and independent operator (IO) on the acquisition price of remanufactured products. This study proposes a two-period model in which manufacturing decisions and remanufacturing pricing policies are addressed.	Numerical study	49
15	An integrated method for evaluating the remanufacturability of used machine tools	Du et al. (2014)	Empirical	Applies the proposed decision-making and evaluation model for analysing remanufacturability, focusing on the remanufacturing process where the other existing studies were limited. For clear understanding, a machine tool has	Case study and Analytical Hierarchy Process (AHP)	48

				been considered as an example and the remanufacturability of the tool concerned was identified with the help of AHP.		
16	Competitive quality choice and remanufacturing	Ösdemir et al. (2014)	Modelling	Investigates the competition that exists between the OEMs and the IO, in which it is assumed that the IO provides the OEMs with competition. The competition is more closely based on the perceived quality of the final product.		44
17	Optimal acquisition and production policy in a hybrid manufacturing/ remanufacturing system with core acquisition at different quality levels	Cai et al. (2014)	Modelling	Presents a stochastically dynamic programming model which is used to analyse the policies and parameters of price acquisition and production within the hybrid manufacturing/remanufacturing system. The model concerned was separated into two levels including high and low quality.	Stochastic dynamic programming	42
18	Remanufactured products in closed-loop supply chains for consumer goods	Abbey et al. (2015b)	Empirical	Analyses the correlation between customer perceptions towards remanufactured products and the way in which they evaluate remanufactured products. Unlike other studies, this study focuses on both positive and negative perceptions of the customers towards remanufactured products.		41
19	Remanufacturing third-party competition, and consumers' perceived value of new products	Agrawal et al. (2015)	Empirical	Proposes and investigates the hypothesis, "the impact of the relationship between the presence of remanufactured products and their influence on increase of new product sales".		38
20	Dynamic pricing for new and remanufactured products in a closed-loop supply chain	Chen and Chang (2013)	Modelling	Proposes a dynamic programming model which works in polynomial time to study the pricing problem for remanufactured products in the closed-loop hybrid manufacturing system over multiple periods.	Numerical study	38

Figure 4. ARTO System's recovery processes

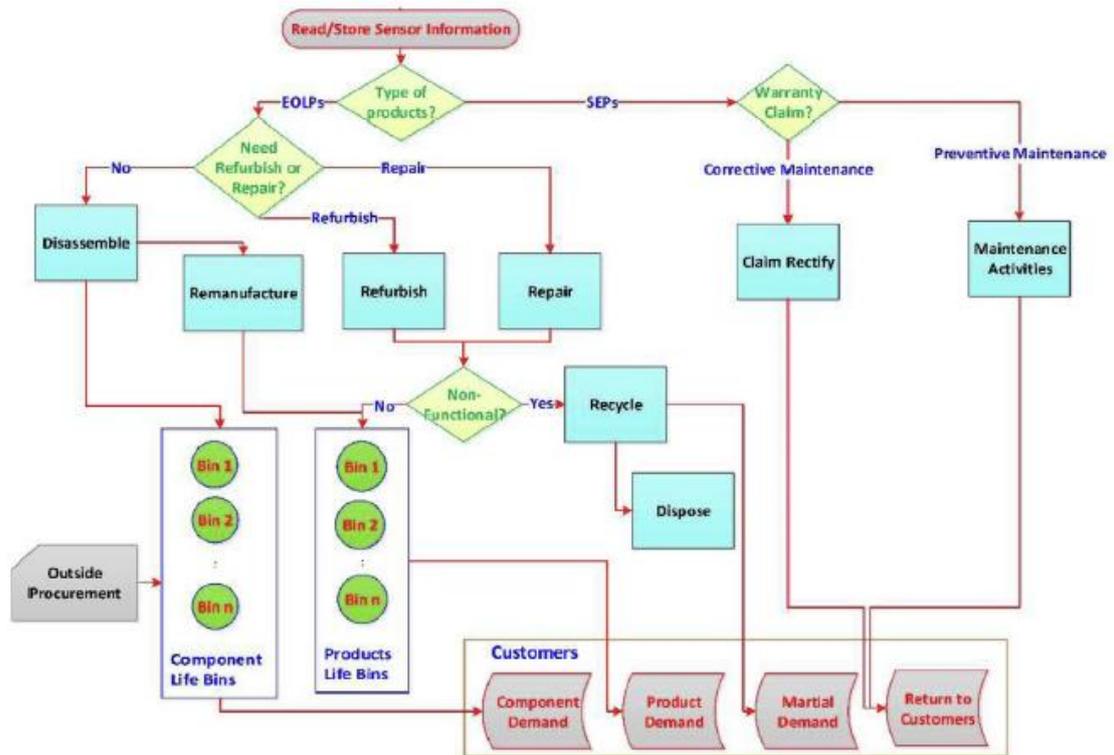


Figure 5. Proposed integrated model for cost, profit and demand functions along with preferences

