Responsible Consumption as A Driver for Remanufactured Products

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Abstract

In recent decades, developed countries have raised in the political, economic, social, and cultural sectors. In this context, nations aim to search for the common welfare, security, technological and commercial competitiveness, and sustainable development. We currently live in a globalized world where we seek to generate wealth by transforming resources, which are primarily finite or only renewable under certain conditions. Due to this problem, other production alternatives have been designed, such as remanufacturing, which seeks to extend the life cycle of products through recovery to meet the population's needs. These practices are more common in developed countries where appropriate incentives, technologies, knowledge, and provisions form a contrast with the emerging countries such as Russia, China, India, Mexico, and Brazil, without capacities fully developed. This article aims to identify the variables intervening in the consumer's perception of remanufactured products to understand the impediments or differences generated to adopt a circular economic model based on responsible consumption.

Keywords
Product life cycle; Circular Economy; Sustainability; Remanufacturing.

1. Introduction

The current lifestyle is very competitive and accelerated; this translates into the manufacturing needs of material products whose function is to provide greater comfort and simplicity in the daily activities of the inhabitants. Modern lifestyles generate the continuous need to be opening production plants in practically all regions of the planet, which will not be a viable and sustainable production option. It is interesting to know how this whole mass production movement began, preceded by the industrial revolution (Hudson, 2014), started in England and spread to different parts of Europe, the United States, and Japan during 1760 1840. During this time, significant changes were generated in societies worldwide, mainly due to the creation and implementation of new methods and technologies applied in mass production, with the steam engine being the pioneer of this movement. It was driven by a fuel based on mineral coal to promote essential industries (textiles, metallurgy, and mining), replacing the traditional iron with a more sophisticated, complex, and resistant metal known as steel. At the same time, commercial activities were developed at a global level, mainly by land transport (use of the railroad) and by sea. Additionally, public lighting was improved by implementing gas-based lamp installations, generating a substantial increase in the population of many cities.

Despite the advancement of technology for the benefit of humanity, the excessive use of these resources has generated negative consequences, mainly due to pollution through organic waste and pollutants in the atmosphere by the gases produced. As a result of this problem of the modern productive world, conventional manufacturing operations seem not to be adequate in the long-term considering the waste and waste of resources that the planet is increasingly challenging to support and therefore requires the application of other production alternatives, remanufacturing being a viable and sustainable alternative for responsible consumers. Responsible consumption lifestyles imply a change in how we produce food (Insfran-Rivarola et al., 2020, Miranda et al., 2020), products, and services, including how we distribute them (Gonzalez et al., 2018) and make their final disposal.

Remanufacturing is the process of returning a product at the end of its useful life by the consumer. This product is known as the core, which is the main product to which disassembly, cleaning, inspection, and assembly processes will be applied, performance tests, and finally, a remanufactured product will be obtained with a guarantee equal to or greater than the original product through the inclusion of improvement phases. Therefore, it is an end-of-life strategy that aims to preserve the product's added value to a greater extent and extend its life cycle (Aljuneidi & Bulgak, 2020, Alqahtani & Gupta, 2017). These practices are applied to different products, which generally correspond to complex metal-mechanical, electronic, or electromechanical products, whereby recovering the components, a relevant added value is generated concerning their market value and their original cost of production. Therefore, thanks to these economic models, goods are produced at low prices, which tend to be very accessible and attractive to consumers. However, remanufacturing still has shortcomings due to its lack of expertise in operational and research terms (Matsumoto & Ijomah, 2013).

Remanufacturing aims to extend the useful life of products, allowing the introduction of technological innovation in remanufactured products to ensure advanced environmental performance over time and satisfy customer preferences. The above, preserving as much as possible the physical resources used in the process. Therefore, upgrade remanufacturing would resolve the intrinsic contradiction between environmental and economic issues in designing a sustainable Product-Service System (PSS).

Objectives. It is essential to develop a general understanding of the variables involved in remanufacturing. Therefore, through an extensive literature review (including books, specialized journals, and international conference proceedings) we proceeded to identify the variables influencing consumer perception of remanufactured products. It is to identify the factors that influence the purchase decision regarding remanufactured products for future work to design and validate a measurement instrument.

2. Literature Review

Manufacturing companies around the world are striving to increase their revenue and profitability through various development plans. For example, it seeks to obtain a more significant share in the market and manage most of the product value chain. It can be achieved in conjunction with obtaining environmental benefits by improving service capacity. By offering a broader portfolio of integrated product services rather than focusing only on physical products, economic opportunities are created in the aftermarket for products, as shown primarily in the automotive industry. Many manufacturing companies are shifting their production philosophies from a traditional focus on manufacturing

the physical product to focusing on the life cycle of the physical product. As a result, it now focuses on the use and end-of-life phases, including maintenance and remanufacturing (Arredondo et al., 2018a; Arredondo et al., 2019).

2.1 Remanufacturing Overview

In Mexico, there was a culture of repair or restoration. Due to the strengthening of the linear economy by shortening the life cycles of products, this culture was gradually lost. There is a tendency to buy new products by discarding the old ones that go to landfills, or in the best of cases end up in recyclers, recovering only the value of their raw material, but losing all the added value it had in the manufacturing process. In order to achieve responsible consumption, it is necessary to reduce the ecological footprint by changing the methods of production and consumption of goods and resources. Industries, businesses, and consumers need to be encouraged to recycle and reduce waste (PNUD, 2020). In addition to recycling, there are more efficient end-of-life strategies, such as remanufacturing based on a circular economy model, where products considered waste are converted into raw material and give at least one other helpful life to the product. Remanufacturing guarantees a product that is as good as new but at a lower price. The process consists of disassembly operations, cleaning inspections, development of recovery operations (to bring each component of the product to design specifications), assembly, and final testing (Soto et al., 2016; Hazen et al. 2017; Arredondo et al., 2018b; Guide, 2000).

2.2 Reverse logistics and remanufacturing

Reverse logistics is a component of the supply chain, where the mobility of products occurs through end consumers to producers. Currently, many companies are looking for ways to improve their processes for preserving the added value of products and avoiding causing problems to the environment. For this purpose, they seek to extend the life cycles of products (Dowlatshahi, 2000). This type of logistics presents a considerable challenge since different operations are involved in the storage, transportation, and handling of previously used products. It is known that critical factors such as quality, quantity, and arrival times are played, all this generating uncertainty for the producers, and therefore it is projected in the consumers of the products generated from reverse logistics operations.
This article aims to identify the variables intervening in the consumer's perception of remanufactured products to understand the impediments or differences generated to adopt a circular economic model based on responsible consumption were reverse logistic process are developed.

3. Methods

Through an extensive literature review (including books, specialized magazines, and international conference proceedings), the methodology consisted of identifying the variables that influence design strategies for value preservation and the purchase decision regarding remanufactured products. A compilation was included to identify variables, models, and methodologies related to customers' perception of remanufactured products and their purchase intention (Jiménez-Zaragoza, et al., 2020).

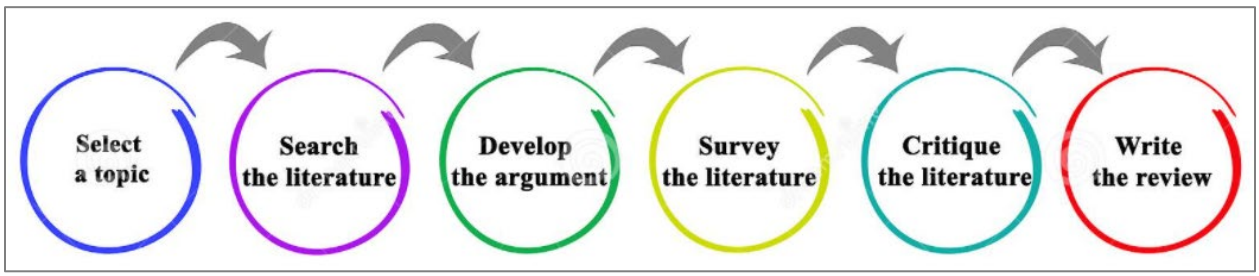

Figure 1 Steps of literature review

4. Results and Discussion

In order to determine the relevant variables, the results of the literature review were taken up. The intervening variables identified in the literature were filtered under the criterion that they are related to external events that are not within the scope or control for this research. Table 1 and table 2 present the critical indicators and variables identified in remanufacturing that affect the customer's perception and purchase decision. The principal authors who carry out the

identification are Singal, Tripathy & Jena (2019b), Milios & Matsumoto (2019), Jimenez-Parra et al. (2014b) Khor & Hazen (2017), and Wang & Hazen (2016b).

Table 1. Variables, models, and methodologies related to design and commercialization of remanufactured products from the consumer perception.

INDICATORS	CRITICAL VARIABLES
1. Risk perception 2. Knowledge about remanufactured products 3. Personal benefits 4. Concern for the environment 5. Market strategy 6. Attitude 7. Subjective norms 8. Perceived behavior control 9. Purchase intention	Risk perception Knowledge about the remanufactured product Personal benefits (Singal, Tripathy & Jena, 2019b).

Table 2. Variables, models, and methodologies related to design and commercialization of remanufactured products from the consumer perception.

Indicators	Critical Variables	Indicators	Critical Variables
1. Knowledge about remanufactured products 2. Personal benefits 3. Risk perception	Risk perception Knowledge about the remanufactured product Personal benefits (Milios & Matsumoto, 2019).	1. Attitude towards buying a remanufactured laptop 2. Subjective norm 3. Motivations 4. Marketing mix variables purchase intent	Attitude towards buying a remanufactured laptop. Subjective norms Motivations (Jimenez-Parra et al. 2014b).
1. Attitude 2. Subjective norm 3. Control of perceived behavior 4. Intention to purchase remanufactured 5. Purchase-energy efficiency 6. Buy-new purchase re-manufactured	Attitude Subjective norm Intent to purchase remanufactured. Purchase-energy efficiency Buy-new. Purchase-re-manufactured Khor & Hazen (2017).	1. Perceived value 2. Perceived risk 3. Purchase intention 4. Knowledge of cost 5. Environmental awareness 6. Quality knowledge	Perceived value Perceived risk Purchase intent (Wang & Hazen, 2016b).

The main critical variables identified are risk perception, knowledge about remanufactured products, personal benefits, attitude towards remanufactured products, subjective norms, motivations, purchase intention, and perceived value, according with table 3. Table 3 addresses the Risk Perception factor that includes variables related to quality, maintenance costs, performance, self-perception, safety, operation, and investment.

Table 3 Risk Perception factor

Arguments considered in the instrument	Variable evaluated and author
1. I doubt the quality of remanufactured products.	Quality (Hazen et al., 2017).
2. I have to spend my time and money on frequent maintenance of remanufactured products.	Maintenance expenses (Bensmain et al.,2019).
3. I think remanufactured products perform poorly.	Performance (Arredondo-Soto et al., 2019)
4. I will be the mockery of others if I buy these products.	Self-perception (Govindan et al., 2019).

5. Remanufactured products are not that good and can put my safety at risk.	Security (Govindan et al., 2019).
6. Remanufactured products do not perform as well as new, which could affect their performance.	Functioning (Matsumoto et al., 2018).
7. Buying remanufactured products is a bad investment.	Investment (Choi, 2017).

Table 4 presents the Knowledge factor about remanufactured products that includes variables such as warranty, modernity, performance, comparison, differences, and spare parts.

Table 4. Remanufactured Products Knowledge factor

Arguments considered in the instrument	Variable evaluated and author
8. I will buy remanufactured products if they have a specific warranty.	Warranty (Liao et al., 2015).
9. I will buy remanufactured products if they have the latest features.	Modernity (Sinha et al., 2016).
10. I am familiar with the performance and characteristics of remanufactured products.	Features (Pandey & Thurston, 2009).
11. I am familiar with the quality of remanufactured products compared to new ones.	Comparison (Ferrer & Swaminathan, 2006).
12. I am familiar with the differences between remanufactured and new products.	Differences (Ferrer & Swaminathan, 2010).
13. I will purchase remanufactured products if replacement parts for critical components are available.	Spare parts (Inderfurth & Mukherjee, 2007).

Table 5 includes the variables: price, government incentives, discounts, savings, and maintenance services that belong to the factor Personal benefits for purchasing remanufactured products.

Table 5. Design Strategy Focused on Personal Benefits of the client factor

Arguments considered in the instrument	Variable evaluated and author
14. I will buy remanufactured products for their low prices.	Price (Frota Neto et al., 2016).
15. If I buy remanufactured products, I can get government incentives.	Government incentives (Singhal et al., 2019b).
16. If I consume remanufactured products, I may have additional discounts.	Discounts (Abbey et al., 2015).
17. Buying remanufactured products instead of new saves me.	Savings (Gutowski et al., 2011).
18. I am willing to purchase remanufactured products if maintenance services are offered to increase the product's useful life.	Maintenance services (Alqahtani & Gupta. 2018).

Table 6 refers to the factor Concern for the environment that is in charge of evaluating the variables: carbon footprint, global warming, contribution to the environment, saving of resources, effects on the environment, extraction of resources, and their recovery.

Table 6. Concern for the Environment factor

Arguments considered in the instrument	Variable evaluated and author
19. I would buy remanufactured products because they lower the carbon footprint.	Carbon footprint (Aljuneidi, & Bulgak,2020).
20. I would buy remanufactured products because they decrease global warming.	Global warming (Biswas et al., 2013).
21. I would buy remanufactured products because they contribute positively to the environment.	Contribution to the environment (Sarigöllü et al., 2021).
22. If I buy remanufactured products instead of new ones, I can save resources and energy in the environment.	Resource saving (Sarigöllü et al., 2021).
23. Buying remanufactured products reduce adverse effects on the environment.	Effects on environment (Sundin & Lee, 2012).
24. Buying remanufactured products reduces over-extraction of primary (virgin) resources.	Resource extraction (Ardente et al., 2018).
25. Buying remanufactured products helps to partially or recover their components at their end of useful life to reinsert them into the production process.	Recovery (Georgiadis & Vlachos, 2004).

Table 7 presents the factors: Market strategy (with its ecolabel, brand, and packaging variables), Attitude (with its Offer and Will variables), Subjective Norms (which is formed by the Friendship and Family variables), Perceived Control behavior (which includes the variables Location and Time / Money) and the Purchasing Intention factor (measured by the Purchasing Motivation and Future Purchases variables).

Table 7. Market Strategy factor

Arguments considered in the instrument	Variable evaluated and author
26. I would buy remanufactured products if they have eco-labels.	Eco-labels (Testa et al., 2015).
27. I would buy remanufactured products from a brand that is more environmentally friendly.	Trademarks (Salimi, 2019).
28. I would buy remanufactured products if their packaging material is environmentally friendly.	Packing (Xu et al., 2020).
Attitude factor	
29. I would love to see an increase in the supply of remanufactured products.	Offer (Alqahtani & Gupta, 2018).
30. I am willing to purchase remanufactured products.	Will (Gaur et al., 2015).
Subjetive Standards factor	
31. I would buy these products if my friends buy them too.	Friendships (Wang & Hazen, 2016b).
32. I would buy these products if my nuclear and/or extended family members buy them.	Relatives (Jimenez-Parra et al., 2014a).
Perceived Control of Behavior factor	
33. I know where I can find remanufactured products for purchase.	Location (Liu et al., 2018).
34. I have enough time and money to buy these types of remanufactured products.	Time and money (Singhal et al., 2019a).
Intent to Purchase Remanufactured Products factor	
35. I am motivated to start buying remanufactured products.	Purchase motivation (Van Nguyen et al., 2020).
36. I will buy remanufactured products in the future.	Future purchases (Gaur et al., 2015).

This information to be collected can be helpful to design and repair strategies to preserve the value of remanufactured products so that consumer perception serves as raw material and proposes PSS that encourage consumer migration to remanufactured products.

6. Conclusion

Through the identification of variables based on the literature, it will be possible to propose a preliminary model where the model will include the 36 variables studied in this paper: seven in the PR component (Risk Perception), six in the RPK component (Remanufactured Products Knowledge), five in the DSFPB component (Design Strategy Focused on Personal Benefits), seven in the CE component (Concern for the Environment), three in the MS component (Market Strategy), two in the A component (Attitude), two in the SS component (Subjective Standards), two in the PCB component (Perceived Control of Behavior), and finally, two in the IPRP component (Intent to Purchase Remanufactured Products). Each variable will be a parameter of the model, as it is represented graphically with a relationship of each variable to its corresponding factor, so initially, there are 36 parameters. In addition, each of the hypotheses tested indicates a relationship between factors. In the future, it is intended to carry out the measurement instrument with the identified variables and apply it in order to obtain an answer regarding the acceptance of remanufactured products in the state of Baja California. Figure 2 propose a preliminary model to determine the Purchase Intention of Remanufactured Products based on components that will serve for the Design of the Value Conservation Strategy, this model must be tested statistically to determine its validity, so further research is required.

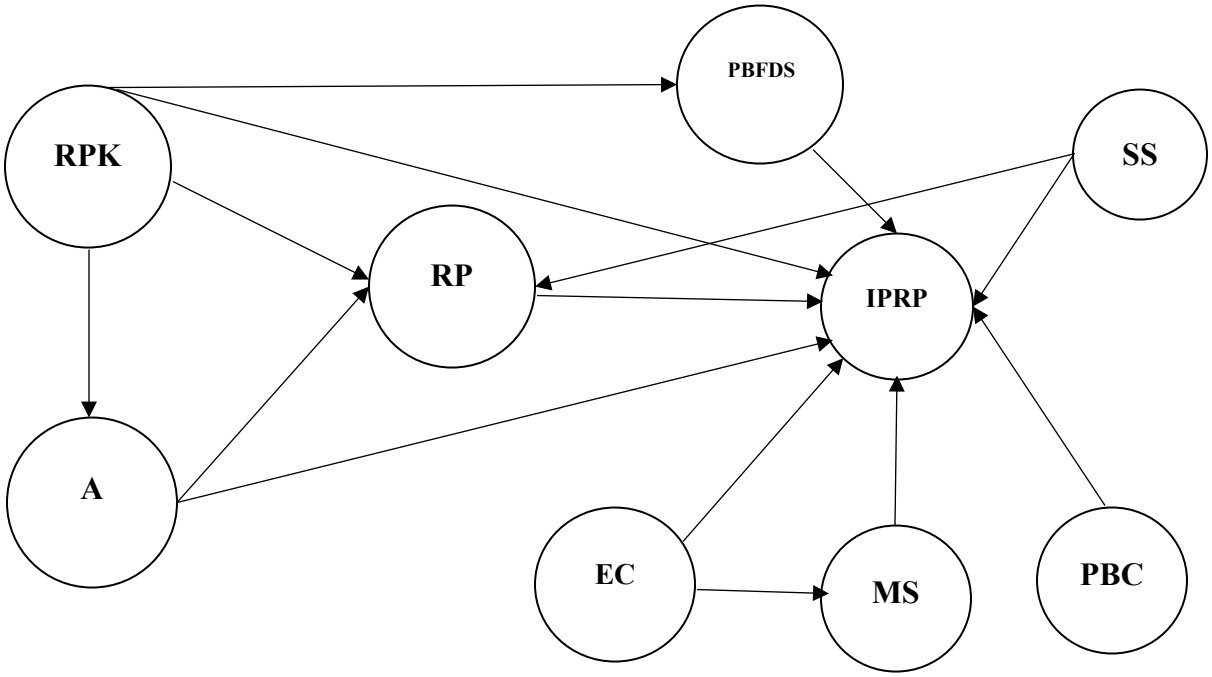

Figure 2 Preliminary Model to determine the Purchase Intention of Remanufactured Products based on components that will serve for the Design of the Value Conservation Strategy.

RPK (Remanufactured Products Knowledge), RP (Risk Perception), PBFDS (Personal Benefits Focused Design Strategy), EC (Environmental Concern), MS (Market Strategy), A (Attitude), SS (Subjective Standars), PBC (Perceived Behavioral Control), IPRP (Intention to Purchase Remanufactured Products).

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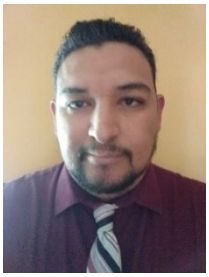

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