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ANALYZING RE-MAKE VERSUS BUY DECISION IN REMANUFACTURING OPERATIONS: ISSUES AND DIRECTIONS

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ABSTRACT

Remanufacturing is a process whereby value from old products is recovered by replacing and recovering used components to bring such products to a new or like-new state. Today, both original equipment manufacturers (OEMs) and third parties are engaged in remanufacturing activities .However, the supply chain sourcing in remanufacturing operations is more complex than traditional manufacturing due difficulty establishment of a sorting policy and the uncertainties associated with the quality, quantities and return timing of used products and components. The aim of this essay is analyzing how OEMs remanufacture can analyse the re-make versus buy decisions. The literature discussing the problem of planning that affect remanufacturing is the difficulty in obtaining products used cores suitable for reuse. The re-make and buy question has always been a concern of complex nature which represents a fundamental dilemma faced by many companies. In particular, under the transaction economic cost applied to remanufacturing can be an important aspect of the assessment, especially understanding of how theory showed that intellectual property, operational assets, and remanufacturing frequency, brand reputation, technological uncertainty, condition uncertainty, product complexity, and volume uncertainty. Finally, the article concludes by providing the insights obtained from the analysis and future study directions in this field.

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INTRODUCTION

Remanufacturing is an economical and eco-friendly activity because it recycles resources and saves energy. The remanufacturing industry has a significant effect on job creation because it is a labor-intensive industry, and remanufacturing provides opportunities to create new markets. Recently, because the changing environmental awareness, many countries have strengthened their environmental regulations and are encouraging remanufacturing activity (Kurilova-Palisaitiene, Sundin and Poksinska, 2018). However, one could question, whether all remanufacturing operations: Why does remanufacturing operations is more complex than traditional manufacturing? Thus, this essay assumes the objective of deepening the discussion on the traditionally, remanufacturing was dominated by small, independent, and privately owned third-party remanufacturers but a growing number of original equipment manufacturers (OEMs) are engaging in these activities due to the potential competitive gains (Martin, Guide Jr. and Craighead, 2010).

A daily question faced by managers is whether the right components and services will be available at the right time to ensure that production can occur and responsiveness. In fact, remanufacturing operations usually involves the difficulty in establishment of a sorting policy and the uncertainties associated with the quality, quantities and return timing of used products and components. A low visibility of the condition, or quality, of product returns increases the risk of delays from suppliers, and increases the costs of drafting the contract (Martin, Guide Jr. and Craighead, 2010). Therefore, one of the problems in the debates about the **problem** and difficulty of planning that affect remanufacturing is the difficulty in obtaining products used cores suitable for reuse (Govindan, Soleimani and Kannan, 2015). Product complexity creates a variety of transaction costs such as the coordination costs between design and disassembly and testing and remanufacturing (Guide Jr. and Wassenhove, 2003). Essentially, Transaction Cost Economics (TCE) argues that certain exchange characteristics increase transaction costs that can be remedied by different governance mechanisms with different cost minimizing features (Williamson, 1985). Under the perspective a (TCE) by building from the extant remanufacturing research coupled with transaction cost economics (Martin, Guide Jr. and Craighead, 2010). This important aspect of remanufacturing operations has received limited attention in the literature. While OEM prevalence in remanufacturing is increasing, research examinations of OEMs engaged in remanufacturing have not kept pace resulting in several gaps. The proposal of this essay consists to investigate one knowledge gap relates to the re-make and buy question has always been a concern of complex nature which represents a fundamental dilemma faced by many companies in the supply chain sourcing in remanufacturing operations (Martin, Guide Jr. and Craighead, 2010). However, whilst taking advantage of this information is important, it should not be assumed that this data is always complete, available or accurate, particularly in the remanufacturing domain where information uncertainty can be commonplace (Goodall *et al*., 2015). As suggest by Sitcharangsie, Ijomah and Wong (2019) a holistic way of integrating different decisions over multiple remanufacturing activities is needed to improve remanufacturing outcomes, which is a major knowledge gap. The impact of condition variability on used product acquisition, sorting, and disposition decisions, areas identified by Guide et al. (2003) has received limited attention. This research presented here aimed at answering: How do OEMs remanufacture can analyse the re-make versus buy decisions?

This essay is structured as follows: In the next section, we specify the definitions of the terms of transaction costs economics and remanufacturing in this paper, with a comparison between these two popular conceptions. In Section 3, which is the core section of this paper, the discussion with detailed examples. Finally, in Section 4, provides the theoretical and managerial implications, and further research directions.

Theoretical foundations

Remanufacturing: Lind, Olsson and Sundin (2014) pointed out awareness among suppliers regarding the value of cores, something that remanufacturers need to increase. The remanufacturing seeks, through an industrial process, that the products used, return to their original specifications and conditions for the repair or replacement of parts, through the process of transformation of products not functional, removed or changed as good as new or "like-new" (Gray and Charter, 2008; Lund and Hauser, 2010). The products used and discarded that reach the remanufacturing process are called cores (Sundin, 2004). According Sitcharangsie, Ijomah and Wong (2019) Material requirement planning (MRP) in remanufacturing is more complex than that of traditional manufacturing, in component planning and scheduling are acquisition cost, purchasing cost, inventory cost, disposal cost, disassembly cost, recycle cost and set up cost. The decision-making should include incomplete disassembly, capacity constraint, adaptive sequence and fluctuating lead-time since these factors affect decision making in the real practice of remanufacturing. According to Östlin (2008) and practices in remanufacturing, the selection of EOL options can be made for remanufacturing activities. EOL options can be determined before and after disassembly, after cleaning, during and after reworking and during reassembly While the common EOL options considered are reuse, remanufacture, recycling and disposal, other EOL options mentioned in the literature include reconditioning, replacement, dismantling/disassembly, repair, salvage, incineration, resale and cannibalizing. Remanufacturing can be differentiated from repair and reconditioning in four key ways (Ijomah, 2009). Remanufactured products have warranties equal to that of new alternatives whilst repaired and reconditioned ones have inferior guarantees. Typically, with reconditioning the warranty applies to all major wearing parts, while for repair it applies only to the component that has been repaired. Remanufacturing generally involves greater work content than the other two processes and as a result, its products tend to have superior quality and performance. Remanufactured products lose their identity while repaired and reconditioned products retain theirs – because in remanufacturing all product components are assessed, and those that cannot be brought back at least to original performance specification are replaced with new components. Remanufacture may involve an upgrade of a used product beyond the original specification, which does not occur with repair and reconditioning (Ijomah, 2009).

In this perspective, remanufacture ability factors can be analyzing under a process perspective once consisting of technology availability, remanufacturing cost, reverse logistic chain. Bulmus, Zhu and Teunter (2014) pointed out the competition between an original equipment manufacturer (OEM) and a remanufacturing machine independent operation. Unlike existing literature, OEM and remanufacturing compete not only by selling their products, but also for the collection of cores through their purchase prices. Demand issues is important in this field, consist of market size or existence of demand, market channel, selling remanufactured products, using either the same channel as new or differentiated product, price of new and remanufactured products, green segment existence. The offer according acquisition price and source of return, whether limited or unlimited is relevant (Gan, Puarwan and Suparno, 2014). Ovchinnikov, Blass and Raz (2014) present an analytical and behavioral model that together incorporate the cannibalization to demand from multiple customer segments across the company's product line company. In the results, they show that remanufacturing often aligns with economic and environmental impacts of companies, increasing profits and decreasing the total impact of environmental. It is possible to identify that, in some cases, the introduction of a product reconditioned means no change in the prices of new products and positioning within the product line, which implies cannibalization with demand and reducing the environmental impact. However, in other cases, the company was able to increase profits by lowering the prices of the new product and increasing sales in a cannibalization with negative demand. Further, product is important factor of manufacturability within innovation rate, residence time, which is the time that the product used is with the customer, residual value of the product, qualitative obsolescence, as an extension of the characteristics of the product (Gan, Puarwan and Suparno, 2014). Subramoniam, Huisingh and Chinnam (2010) pointed out valuable guidance to OEM suppliers to make strategic decisions on the remanufacturing of the products. Thus, it was possible to identify that remanufacturing collaborates strategic decisions and brings a deep reflection on care and factors selected to help automakers launch remanufactured products effectively and efficiently.

Remanufacturing under a Transaction Cost Economics (TCE) perspective: TCE posits that such hierarchies offer greater protection for specific assets and provide relatively efficient mechanisms for responding to change when coordinated adaptation is necessary. Drawing from this literature base coupled with CLSC literature, this study examine asset specificity, uncertainty, frequency, and complexity as transactional dimensions (Martin, Guide Jr. and Craighead, 2010; Williamson, 1985, 1998). The theory of transaction costs, in one of its international management applications, affirms that the cost of finding, negotiating with and monitoring local partners influences the decision on how to enter a foreign market. While transaction costs may occur ex ante (e.g., costs of drafting and negotiating contracts) or ex post (e.g., costs of monitoring and enforcing agreements)—the key premise of TCE is the trade-offs between costs associated with various governing mechanisms. These costs initially arise because of the difficulties of estimating contingencies and the inability to define fair value due to asymmetric information. After an entry decision has been made, the cost of monitoring the partner can also be high due to the distance, communication problems and the dearth of measurable results (Williamson, 1985). The core assumptions of TCE are based on human behavior and include bounded rationality and opportunism (Grover and Malhotra 2003). Williamson (1985) defines asset specificity as the transferability of the assets that support a given transaction. Product recovery requires investments (e.g., test-sort disassembly equipment, training programs) to capitalize on these assets. These assets involved in remanufacturing operations should be safeguarded and protected from relationship hazards with suppliers. TCE posits that there exists an organizational arrangement that minimizes overall costs of governing in light of protecting these assets (Martin, Guide Jr. and Craighead, 2010).

Operational assets: Remanufacturing operations often require specialized physical assets such as equipment, machinery, or facilities for testing, sorting, and processing product returns. The assets required for remanufacturing that cannot be used for any other purpose outside processing a specific type, or brand, of product return are considered specific investments. These assets, unless kept internal, expose the firm to hold-up risks with contractors or partners. Operational assets also refer to the transaction-specific. Specialized training required operators to disassemble and reassemble recovered products, diagnostic skills to identify failed parts, and the effects of learning by doing constitute transaction-specific investments in remanufacturing. As the level of skill specialization and learning-by-doing effect increases, the cost of market mechanism in supplying the labor increases. TCE proposes that hierarchical governance offers greater protection when coordination is essential regarding specific assets (Martin, Guide Jr. and Craighead, 2010). Proposition 1: *Specificity of operational assets is positively related to the level of in-house remanufacturing.*

Brand reputation: Remanufacturing firms can be exposed to relationship hazards relative to its strategy assets. Brand-name capital specificity refers to investments in brand reputation. The OEM must control the quality and the reliability of remanufactured product to protect brand-name capital and, therefore, the need for coordination and monitoring is high (Martin, Guide Jr. and Craighead, 2010). Client acceptance is seen as a barrier, resulting in a large amount of academic work (Atasu, Sarvary and Van Wassenhove, 2008). Therefore, the origin of the country is related to the intensity with which these characteristics are manifested. The perception of inferior quality of remanufactured products, making the willingness to pay for them significantly smaller (Abbey and Guide Jr., 2017). According to Subramonian and Subramonyam (2012), in the remanufactured product market, it is important for sellers to build and communicate their reputation. Reputation mechanisms can provide signals about product or service quality and help mitigate the uncertainties faced by potential purchasers of remanufactured products.

Intellectual property: Another strategic asset is proprietary technology embedded in OEM products and processes. IP is an asset that is hard to transmit across organizational boundaries, and when transmitted it is subject to hazards of sharing and valuation. In remanufacturing, products containing high levels of proprietary technology are subject to hazards of exposure during disassembly (Martin, Guide Jr. and Craighead, 2010). Proposition 2: *IP is positively related to the level of in-house remanufacturing.*

Uncertainty: Uncertainty in the environment is an important dimension of TCE and as insignificant variable in remanufacturing operations. Environmental uncertainty refers to "unanticipated changes in circumstances of an exchange" and creates adaptation problems, as agreements must be modified as the circumstances of the exchange changes (Martin, Guide Jr. and Craighead, 2010).

Volume uncertainty: Volume uncertainty in remanufacturing is the inherent difficult in predicting the number of cores returned. From a TCE perspective, volume uncertainty causes the company to update contracts and causes high coordination and renegotiation costs. This uncertainty may cause suppliers to experience high production costs and excess capacity and OEMs can experience stock-outs, or excess inventory (Martin, Guide Jr. and Craighead, 2010).

Technological uncertainty: Technological uncertainty is the frequency of changes in product specification and the probability of technological improvements. When product specifications change frequently, or there are short product life cycles, technological uncertainty may pose a problem for remanufacturing, especially in the form of time value lost during remanufacturing operations. To avoid high levels of returned-product obsolescence, companies must have agile process and responsive disposition policies. From a TCE perspective, the difficulty in accurately forecasting new technical or design requirements for disassembly creates adaptation problems and incurs high renegotiation and coordination costs (Martin, Guide Jr. and Craighead, 2010).

Condition uncertainty: Condition uncertainty is defined as the variability in the quality of returned products. Assessing products prior to remanufacture is an important part of the remanufacturing process, ensuring that unsuitable cores are removed at an early stage to avoid unnecessary processing. Condition uncertainty affects the planning of materials and labor and causes capacity management problems in remanufacturing facilities. Variability in the condition (quality) of products increases the variance of the expected processing times and the condition of the returned product is variable in deciding optimal recovery action (Martin, Guide Jr. and Craighead, 2010).

Frequency: In the TCE context, frequency is their currencies of transactions (Williamson, 1985). In a remanufacturing context, frequency of remanufacturing is a function of the number of times a core can be remanufactured and the timing of returns. This results in the potential frequency of transactions between the OEM and its supplier. The utilization of remanufacturing machinery, equipment, and labor essentially depends on the timing of returns and the number of times a product can be remanufactured. When remanufacturing transactions are not frequent enough, firms may prefer to contract the operations rather than investing in fixed assets and incurring the operational costs of a rarely occurring transaction (Martin, Guide Jr. and Craighead, 2010). Proposition 3: *Frequency of remanufacturing is positively related to the level of in-house remanufacturing.*

Product Complexity: Product complexity creates a variety of transaction costs such as the coordination costs between design and disassembly and testing and remanufacturing (Guide Jr. and Wassenhove, 2003). Thus, for the purposes of positioning, in this essay, adopts Lund (1984) established seven criteria that determine if a product is suitable for remanufacturing: it is a durable good; is discarded; is standardized and its parts are interchangeable; has added value; the cost of product return is lower compared to value added; is technologically stable; and if the consumer is aware that there are remanufactured products. Questions regarding product price, product maturity, product design, product differentiation potential, increasingly influence product remanufacturing (Martin, Guide Jr. and Craighead, 2010). Proposition 4: *Complexity of the remanufactured products is positively related to the level of in-house remanufacturing*

The following section explain discuss key remanufacturing re-make versus buy decision issues.

DISCUSSION

Martin, Guide Jr. and Craighead (2010) pointed out the building from the extant remanufacturing research coupled with TCE (Williamson, 1985), the authors investigate the potential drivers of the remake versus buy decision for OEMs engaged in remanufacturing. The results suggest that specificity of operational assets, IP concerns, and frequency are primary drivers of in-house remanufacturing. Conversely, the study did not find support for brand reputation, technological uncertainty, condition uncertainty, volume uncertainty, and product complexity as drivers of in-house remanufacturing. Collectively, these results represent an important first step toward a better understanding of strategic issues related to remanufacturing, particularly the re-make versus buy decision. Specifically, the study were able to provide extensions, alternate explanations, and, in general, capture the "why" or "why not" relative to each of the theorized relationships. This essay discusses how the TCE assumes the actors (individuals, economic agents and organizational groups) have a limited ability to process available information. By this theory, the actors are considered rational, but in a limited way, so that the decisions taken are satisfactory and not optimal. Since there are rational limits, the transactions can be planned, considering probable variables, being able to generate the best possible result in that context. It seems clear that without rational limits, all transactions could be planned taking into account all likely variables, which would result in an action with the best plausible outcome. Therefore, contracts could be formulated providing for all possible events, which would eliminate uncertainties; however, the rationality of agents is in fact limited. In this sense, according to Williamson (1985), hierarchical organization emerges as a possibility of reducing these uncertainties. The companies move forward to avoid investments in specific assets and very high switching costs (Williamson, 1991). Mahapatra, Narasimhan and Barbieri (2010) also suggest that it is necessary to balance the type of governance between relational and transactional in order to be more effective. Innovative and products with short lifecycles that present uncertainties limit the development of long-term oriented partnerships with more relational characteristics, motivating the development of relationships based on renewable contracts. In situations where there is low strategic interdependence among members, these contracts safeguard the dominant party's interest, while in cases where there is greater strategic interdependence contracts result in greater effectiveness in governance (Mahapatra, Narasimhan and Barbieri, 2010). First, there appears to be a "boundary" to this relationship.

In remanufacturing, the uncertainties, in terms of volume of return, time and quality of the core, core acquisition is a critical and challenging issue for remanufacturing (Govindan, Soleimani and Kannan, 2015; Wei, Tang and Sundin, 2015). From a TCE perspective, volume uncertainty causes the company to update contracts and causes high coordination and renegotiation costs (Poppo and Zenger, 1998). In a remanufacturing context, the frequency of remanufacturing is a function of the number of times a core can be remanufactured and the timing of returns. This results in the potential frequency of transactions between the OEM and its supplier. Here, the distinct The presence of opportunistic behaviors, mentioning the "dark side market" and thus requiring governance structures based on formal safeguards (Grover; Malhotra, 2003; Williamson, 1985), and restricting to intellectual property (IP) and product patents. At remanufacturing, products that contain high levels of proprietary technology are subject to exposure during disassembly.

This study is in line with Ijomah (2009) once the key remanufacturing problems relate to the paucity of knowledge in the area and its relative novelty in research terms and include the ambiguity in its definition leading to its confusion with repair and reconditioning. The paucity of readily available remanufacturing tools and techniques. Remanufacturers perceive the scarcity of effective remanufacturing tools and techniques as a key threat to their industry. The poor remanufacturability of many current products because design has typically focused on functionality and cost at the expense of environmental issues. Combine ecological concerns, economic growth, and the significance of secondary market processes, in particular, remanufacturing in sustainable manufacturing. Hence, to achieve the proposed goal, to consolidate the debate, by the following five major reasons influence re-make versus buy decisions. First, cost analysis refers to the determination of cost to make an item as well as cost to buy it. The second is related to internal capacity in equipment's, necessary skills and time it makes sense to produce items in-house otherwise go for outsource. Exploit external sources, learn from outsiders and increase product diversity etc. Access outside sources' competence or technology advantages difficult or costly to attain in-house. Third, expertise and skill, understanding the experience in the firm. It is important to get a few knowledgeable employees together. Fourth, the quality consideration, once outside suppliers who specialize can usually offer higher quality products than what the firm can produce. However, a unique quality requirement or the desire to monitor the quality may cause a firm to decide to make. Finally, analysis when the demand for a product is high and stable. It is better for the firm to produce the item rather than buy. Alternatively, when fluctuation in demand or small orders have to be handled, it is better to buy the item from multiple sources who are specialists. In addition to this interesting insight into the key factors that explain the price differentials between new products and remanufactured the reputation of the seller of the products and the producers of the products (OEM versus independent manufacturers). These key findings can be useful to a company when deciding whether to remanufacture a product or not, as it is subject to scrutiny of external elements to obtain legitimacy. The emphasis on end users should be on a good price-quality ratio instead of mentioning all kinds of environmental properties of remanufacturing, as firms must maintain the reputation of a shared brand. A plausible alternative explanation for one of the reasons for the OEM to carry out its remanufacturing is to prevent the supplier (client) from doing it with a third party buyer. It is assumed that the buyer (OEM) can, through remanufacturing, achieve a form of environmental innovation by developing a long-term relationship with its customers. An interesting aspect of the problem, built on success, reward, and value propositions, is that the supplier, in developing his strategy to return the core and thus close the reverse chain cycle, develops a form of environmental innovation because it involves considerations on the inherent and strong incentives for the buyer to develop a substitute. Which, on an individual basis, would not be possible. The major implication as discussed earlier, this research indicates that there is opportunity to build on work by introducing and considering the product market implies the need and important that the sellers build and communicate their reputation. This is in line with Subramanian and Subramanyam (2012) who reveal that reputation mechanisms can provide signals about the quality of the product or service and help mitigate the uncertainties faced by potential product buyers remanufactured.

Conclusion

The aim of this essay was to deepen the discussion on how OEMs remanufacture can analyse the re-make versus buy decisions. Based on the review of the literature, supply chain sourcing in remanufacturing operations is related a decision being made at one remanufacturing activity will greatly affect the decisions at subsequent activities, which will affect remanufacturing outcomes, i.e. productivity, economic performance effectiveness, and the proportion of core that can be salvaged. The results suggest that specificity of operational assets, IP concerns, and frequency are primary drivers of in-house remanufacturing. These issues should be address to support the challenges of remanufacturing companies may be exposed and concerning the relationship risks and reputation as to the strategic assets. The specificity of brand capital refers to investments in brand reputation. Self-named capital increases the likelihood of remanufacturing companies need to maintain a reputation for a shared brand. The OEM must control the quality and reliability of the remanufactured product to protect the capital and therefore the need for coordination and monitoring is high. If each of the remanufacturers' suppliers does an assessment and concludes that the total profit will increase when disassembling cars to get components, more cores will be available and the gap between supply and demand will decrease. A further advantage that remanufacturers will gain if the awareness of the value of cores is raised is that the handling of cores will be more careful. This could lead to the remanufacture of more cores. If assessments are executed, and they show that the total profit will increase when cars are disassembled in order to get components, this will lead to a win-win situation where the profit will increase for the scrapyards and more cores will be available for the remanufacturers, so that they in turn can increase their profit. As an important avenue for realizing the sustainable development strategy, remanufacturing products or components will particularly efficiently help reduce the demand for raw materials and in particular keep the physical assets and economic value of raw materials already contained in products. Further, it is seen as one of the main strategies in the transition to a circular economy. Therefore, for to examine the advantages and disadvantages of integration the hybrid mechanisms of relational and transactional governance in remanufacturing, is an important direction for future study. Therefore, future research could look at the role of relational competencies for understanding how organizations combining resources through articulation in their relationships, focus on long-term, to obtain the core.

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