SALE OF SECOND-HAND AND REMANUFACTURED COMPONENTS OF CONSTRUCTION EQUIPMENT: AN EMPIRICAL STUDY OF USER PERCEPTION IN ANDHRA PRADESH

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Abstract

The construction industry plays a pivotal role in shaping infrastructure and development, contributing significantly to economic growth and urbanization. In recent times, the sector has been seeking innovative ways to maximize efficiency, reduce costs, and promote sustainability. One promising avenue is the exploration of second-hand and remanufactured components for construction equipment, which has the potential to bring about substantial benefits for both businesses and the environment. This study explores the utility, availability, and compatibility of second-hand and remanufactured components for construction equipment, aiming to determine their potential to enhance machine productivity and contribute to revenue growth. The research methodology employs quantitative analysis to collect data from second-hand dealers across Andhra Pradesh. Additionally, consumer behavior is observed during the purchase of second-hand components, with a focus on relevant focus groups in this region. The study reveals that customer awareness and understanding of the technical aspects, usability, price comparisons, and compatibility of second-hand construction equipment parts are limited. Due to the lack of accessible testing facilities for remanufactured parts, customers often rely on their instincts and past experiences. Despite this, customers generally hold a positive perception of purchasing second-hand or remanufactured components. Furthermore, the high costs and scarcity of original parts at authorized dealerships drive customers towards buying components from the second-hand market.

Keywords: Construction Equipment, Remanufactured Parts, Second-Hand Parts, User's Perception

1. INTRODUCTION

Spare parts play a crucial role in maintaining and operating construction equipment, and the demand for these parts, whether old or newly manufactured, arises intermittently. With equipment having a lifespan of around 30 years, the annual consumption of spare parts can amount to 2.5% of the purchase price (Adrodegari et al., 2011). Used parts, salvaged from aging equipment, are stored by vendors and resold to customers when suitable and usable. Remanufacturing, on the other hand, is a process that aims to restore used products to a like-new condition, ensuring their performance matches that of new products.

Remanufacturing is defined as "an industrial process in which worn-out products are restored to like-new condition" The Indian Construction equipment market comprises earthmoving machinery, concrete mixers, material-handling equipment, and road construction equipment. Some of the major players in the Indian construction equipment market are Caterpillar, Komatsu, Hitachi, Kobelco, Volvo, Sany, JCB, and XCMG. By 2025, the Indian construction equipment market is expected to exceed 4.7 billion U.S.

dollars. Machinery often works in extreme conditions, such as highly dusty places, deep mines with low atmospheric pressure, places inhabited by salt water, and extreme altitudes. These machines are highly vulnerable to sudden breakdowns because of their operating conditions. Breakdowns can occur for simple reasons, such as a blown fuse to a more critical transmission problem or an engine overhaul. Components of the construction equipment are imported from countries such as China, Germany, USA, Sweden, and Italy, and are assembled at plants located across India. These components are proprietary in nature and have several patenting licenses, and cannot be easily replicated.

The cost of importing and stocking components escalates the original price several times. Authorized dealerships need to maintain a sufficient inventory of consumables and critical parts for the smooth operation of machinery. Procuring parts from abroad, storing them in big facilities, transportation, inventory management, dealer margins, etc. will increase the prices of the component exorbitantly. Each piece of equipment has thousands of integrated components for its overall functioning. An authorized dealer and/or manufacturer can't maintain the stock of all components. Hence, it is highly unlikely that a customer will find a suitable component immediately upon breakdown. Often, second-hand market and aftermarket parts will rescue the customer in the event of a sudden breakdown. Aftermarket parts may not be precisely suitable and are often spurious. Therefore, customers look for a convenient and reliable second-hand or remanufactured component. Digitization not only helps customers find suitable products but also saves time and money.

This is a prerequisite for the current study to be methodologically based on content analysis of a variety of different documents, their logical and descriptive presentation, and for it to rely mainly on fragmented statistical data from different sources. Through the method of induction and deduction of their content, the primary trends of the second-hand component markets are expected to become clearer. Often, consumers face difficulty in locating a suitable second-hand part as the information about it is not readily available.

Although second-hand dealers use word-of-mouth publicity, social media, and the distribution of leaflets to attract customers, it is still not sufficient to capture relevant information by the consumer. Several dynamics were simultaneously at play. The technicalities of the component, its reusability, compatibility, price worthiness, and potential failure risk discourage consumers from contemplating its purchase. However, most of these disadvantages are negated when an experienced technician is involved in the purchase or when the component is directly removed from the scrapped machine and sold. Furthermore, remanufacturing supports local economies by generating skilled jobs and expertise. It enhances the availability of components, helping equipment owners and operators access parts efficiently and economically. As technology advances, digitization can play a pivotal role in facilitating the identification and availability of suitable remanufactured components. Integrating AI-driven databases can streamline the matching process, allowing customers to quickly locate the right part and ensuring a seamless transition from breakdown to repair.

Creating equipment where used part information is entered into a database and matching it to consumer needs along with artificial intelligence (AI) technical assistance will substantially increase the chances of finding the right part quickly. Therefore, this study is conducted to comprehensively explore and analyze the dynamics surrounding the

use of used and remanufactured components in the maintenance and operation of construction equipment. Through empirical investigations and quantitative analysis, the aim is to assess the utility, availability, and suitability of these components and their potential to increase machine productivity and contribute to revenue growth. By focusing on user perceptions and behavior in Andhra Pradesh, this research seeks to uncover consumer awareness, understanding, and preferences regarding used and remanufactured parts. By examining factors such as consumer awareness, technical complexity, cost-effectiveness, and environmental sustainability, this study aims to provide insight into the feasibility and viability of incorporating used and remanufactured components into the industry. Additionally, this study aims to propose strategies or frameworks that can improve the accessibility, reliability, and convenience of sourcing these components, potentially contributing to increased operational efficiency and cost savings for equipment users.

2. LITERATURE REVIEW
2.1. Product Quality

Identifying second-hand and remanufactured components has become easy with the widespread availability of e-commerce platforms and B2B businesses like Indiamart and TradeIndia. For instance, the global market of second-hand cars has reached 10.2 billion units during the third trimester of 2018 (Tao & Edmunds, 2018), In 2017, the global market of pre-owned or used furniture comes to a sum of 29.3 billion USD and is predicted to continue growing at an annual rate of 6.4% by 2025 (Nester, 2017). The resale market for mobile phones on a global scale reached 19 billion USD in 2017, with the prospect of expanding to 44 billion in 2026 (Market, 2018). The constant development of the second-hand component market influences the new component industry as it is a niche market segment (Williams & Paddock, 2003). There is a lack of statistical information on the sales of second-hand parts. Its studies are few and mostly geographically and product-specific (Guiot & Roux, 2010).

There are four important characteristics of spare parts of construction equipment which have greater significance. Firstly, intermittent demand patterns are common among spare parts. They are designated by a series of zero-demand observations diversified by occasional non-zero demand (Boylan & Syntetos, 2010). Hence, spare parts demand is very difficult to predict. Second, the number and variability of spare parts are generally very large. Third, reducing the risk of spare parts' obsolescence is important to minimize stocks. Fourth, the consumption of spare parts is closely related to maintenance. Some previous works have reviewed academic research on spare parts management. Silver (1981) undertook a broad review of operations research in inventory management. (Kennedy et al., 2002) reviewed research papers on management issues, age-based replacement, multi-echelon problems involving obsolescence, repairable spare parts, and special applications.

Syntetos et al. (2009) focused their review on forecasting for spare parts management, while (Syntetos et al., 2009) reviewed the literature on forecasting for inventory planning. (Paterson et al., 2011) reviewed research on inventory models with lateral transshipments. (Bacchetti & Saccani, 2012) carried out a literature review of spare parts classification and demand forecasting and investigated the gap between research and practice in spare parts management. (Bakker et al., 2012) undertook a review of recent research on inventory systems with deterioration. (Basten & van Houtum, 2014) reviewed

contributions relating to system-oriented inventory models for spare parts. (Syntetos et al., 2016) provided a comprehensive review of the literature on supply chain forecasting.

Remanufacturing has the prospect to instigate higher resource efficiency within the circular economy. There is a ubiquitous perception among consumers that remanufactured and previously used parts might be of lower quality than their respective newly manufactured equivalents. The economical price of second-hand products has conventionally associated with incorporating their perceived inadequate quality and hence increasing the appeal of remanufactured goods in the market. Well-informed consumers would easily differentiate the quality and efficiency of remanufactured goods, which can be equal to new products.

Consumers' knowledge of the product and its specifications will influence its appraisal and further influence purchasing behavior. In a previous study, Matsumoto et al. found that 80% of US consumers have heard about the existence of remanufactured auto parts, whereas only 20% of Japanese consumers have been familiar with the term "remanufactured auto parts". Hazen et al. found a link between consumers' "tolerance for ambiguity" (the level of tolerance related to a situation, in case of complete absence of information, e.g., the process of remanufacturing or product-related properties) and their willingness to pay for a product, which indicates that knowledge of the product or process leads to higher purchase intention of a remanufactured product.

Buying a remanufactured part involves the consumers' perception of the product quality, its lifespan, serviceability, efficiency and the considerable price gap between new and remanufactured parts. Second-hand parts are perceived as high-risk purchases by consumers because of conflicting claims on product properties by the vendors. On the other hand, several perceived benefits of buying remanufactured products could turn consumers into adjusting their purchase preferences. Among the benefits of remanufacturing, there are considerable material and energy savings, shorter production lead times, additional market capture opportunities, and a socially positive impact, not least by creating new job opportunities.

Introducing the hypotheses, the following statements are put forward for consideration:

- H1: Second-Hand or remanufactured products are purchased significantly during emergencies.
- H2: Contribution of second-hand and remanufactured components in a considerable increase in efficiency and revenue growth of the equipment.
- H3: Knowledge of the products, their specifications, and perceived benefits influence the purchase of second-hand and remanufactured goods.

3. RESEARCH METHODS

The study is based on a combination of quantitative and qualitative analysis, considering elements such as knowledge of second-hand and remanufactured components, along with consumers perceptions of advantages and disadvantages. A comprehensive survey was conducted through a comprehensive questionnaire administered to the target respondents.

3.1. Sample Respondents

Potential consumers, vendors, experts, and scholars are concerned about second-hand and remanufactured components of construction equipment. Initially, this study focused on interviewing industry experts, gaining insights into the second-hand and

remanufactured component markets. Expert opinions and suggestions were integrated, shaping the questionnaire's structure. One of the experts, Mr. B D R Prasad, is an assistant manager at Hyundai Construction Equipment authorized dealership (United Power Service), with expertise in construction equipment servicing and spare parts sales. Insights were also gathered from experts like Mr. Y. Krishna Mohan, who owns a fleet of construction equipment, and Mr. S. Krishna from SK Traders, providing valuable perspectives. The formal survey, based on expert interviews, was conducted from April to June 2023, with 205 respondents participating.

3.2. Research Strategy

A comprehensive analysis was conducted on consumer perceptions, attitudes, and realized value concerning second-hand and remanufactured components. The framework for expert interviews was established to align with the current and future evolution of the second-hand and remanufactured parts market.

3.3. Materials

Key behavioral patterns influencing the choice of second-hand and remanufactured parts were distilled from expert opinions, enhancing the questionnaire's quality. Descriptive and factor analyses were utilized, considering demographic factors like age, gender, occupation, and field experience in questionnaire design. Questions addressing consumer perception and the purchase decision-making process were also included.

3.4. Survey Method

The survey method identified consumers' knowledge of repair and their perception of second-hand and remanufactured parts. A set of 8 questions assessed consumer understanding of the advantages and disadvantages of these products. The survey aimed to uncover consumers' intentions regarding quality, compatibility, and expectations for guarantees associated with second-hand and remanufactured parts.

Consumers' perception of second-hand and remanufactured components was evaluated using a Seven-Point Likert scale (ranging from 1, "strongly disagree," to 7, "strongly agree"). The questions covered product knowledge, advantages of purchasing second-hand and remanufactured parts, and disadvantages of such purchases.

4. RESULTS AND DISCUSSION

In order to attain the primary objective of this research paper, an extensive analysis was conducted on the information and data obtained from the execution of the questionnaire, interviews, and secondary data sources. This analysis led to the following results.

4.1. Descriptive analysis of the survey

About 120 respondents (total respondents- 200, out of a total 205 respondents 5 of them gave erratic answers and hence were not considered) which is 60% of the total respondents are in favor of buying second-hand or remanufactured products provided:

a. The parts are available within a distance of 150 km from their worksites.
b. The vendor is qualified and experienced so as to assist them in choosing the product.
c. A flexible mode of transportation is available from the sellers' place to the consumer's work site.

    d. The price of the component is 50% less than the original new part.
    e. Suitable aftermarket parts are not readily available in the market.
   f. The nature of the breakdown of the equipment is unforeseen.

Any or all of these factors affected the sale of second-hand and remanufactured parts. However, they are positive irrespective of the aforementioned limitations and agree to buy the parts when their equipment's productivity is improved and adds up to revenue growth because of second-hand or remanufactured products. Among the respondents, 82 members (40%) favored buying new and original parts from the manufacturer. And 8% of these respondents (about 6 members) also favored importing the new parts when they are not available indigenously. Oftentimes the cost of remanufactured products is higher than the cost of second-hand parts. Therefore, only 14% of the 120 respondents (about 17) were interested in buying remanufactured parts.

Among the 120 respondents interested in purchasing second-hand or remanufactured components, 5% (6 respondents) prefer to buy remanufactured parts instead of second-hand parts. Among the 80 respondents who have no intention of purchasing either second-hand or remanufactured parts, a strong belief exists that the following factors were taken into consideration when making a purchase:

    a. Suitability of the product.
    b. Detailed specifications and information availability of the products.
    c. Performance and quality of the product compared to original & new.
    d. Guarantee available on the products.
    e. Consumer & vendor knowledge of the product.

4.2. Factor analysis

The willingness to pay is defined as "the maximum price a buyer is willing to pay for a given quantity of goods or services". "The perceived value determines the customer's willingness to pay and thus the price a company can charge for its product". Hence, there is a direct correlation between a consumer's perceived value and the decision to purchase, which can be observed from the following scatterplot.
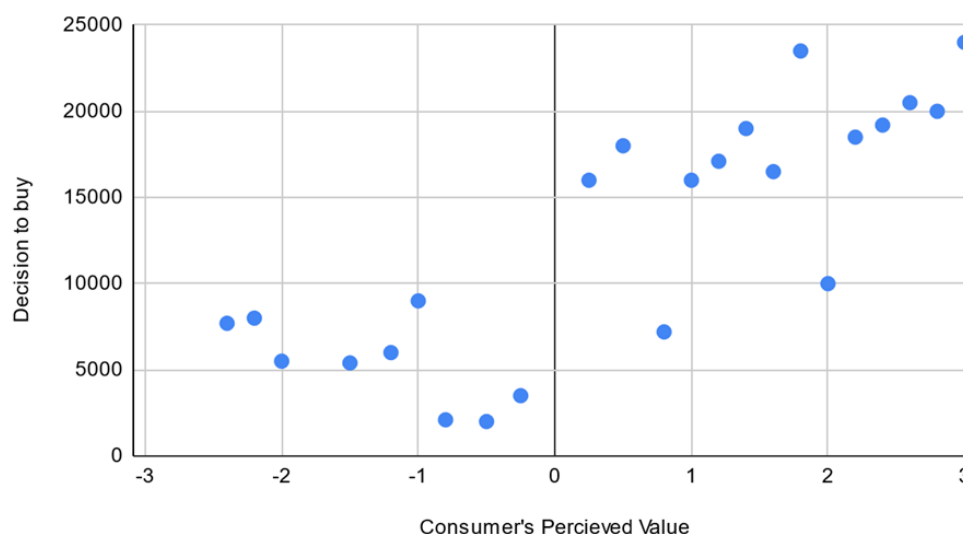
Figure 1. Scatterplot of Consumer's Perceived Value and Decision to Buy

Regression analysis was conducted to establish the relationship between consumers' perception of the value of second-hand or remanufactured parts and their decision to purchase. The findings indicated that a higher perceived value among consumers correlated with a greater willingness to make a purchase at an elevated price. The regression model, a widely-used tool, was employed to explore the connection between the dependent variable (DV) and one or more independent variables (IV).

The data analysis led to the conclusion that the trend of purchasing second-hand and remanufactured components for construction equipment is on the rise and gaining momentum. Even consumers who initially intended to buy new and original parts are considering the option of purchasing second-hand and remanufactured parts due to the scarcity of components available from OEM dealers. Moreover, factors such as product knowledge, proximity of availability, and past experience were identified as significant contributors and determining factors in the decision to buy second-hand and remanufactured parts for construction machinery.

Additionally, it is advisable to continue incorporating insights from expert interviews to enhance the concept of sustainable consumption and promote second-hand consumption. Identifying key motivators for consumer choice of second-hand and remanufactured goods and further improving the quality of these goods can have a positive impact.

Upon careful evaluation of the experts' opinions during interviews, the following observations emerged:

a. The second-hand and remanufactured component market is experiencing remarkable growth.
b. Consumer decisions to purchase second-hand and remanufactured parts are influenced by previous knowledge, experience, and availability.
c. Factors affecting the decision-making process for second-hand and remanufactured parts, as well as consumers' hesitations and concerns, were identified.

Therefore, this research endeavor has yielded valuable insights into consumer perceptions and behaviors regarding second-hand and remanufactured components for construction equipment, there are certain limitations to acknowledge. First, the study focused specifically on the region of Andhra Pradesh, potentially limiting the generalizability of findings to a broader context. Additionally, the research primarily relied on quantitative data gathered through questionnaires and interviews, which may not fully capture all intricacies of consumer decision-making. Furthermore, external variables and influences beyond the scope of this study could also impact purchasing decisions. Despite these limitations, the findings provide significant contributions to understanding consumer preferences and trends in the market for second-hand and remanufactured components.

5. CONCLUSION

In conclusion, this study delves into the intricate realm of consumer behavior, emphasizing the influential role of perceived value in purchase decisions. As consumer preferences shift towards prolonging product lifecycles and reducing environmental

impact, the lack of comprehensive information hinders the adoption of second-hand and remanufactured components. Bridging the communication gap between vendors and consumers emerges as a critical challenge. Addressing this gap through an application-based software shows promise in altering consumers' perceptions and encouraging the uptake of sustainable options. With a multitude of vendors holding significant stocks of components, efficient information sharing remains a crucial step forward.

The study also sheds light on the fragmented communication prevalent within the construction equipment sector. As previous research underscores, purchase intention is intrinsically linked to perceived risk, benefit, and knowledge. To enhance productivity and revenue growth, a thorough grasp of the second-hand and remanufactured market becomes paramount for equipment operators. Embracing digital solutions that integrate stakeholders and provide reliable information can revolutionize industry practices, mitigating downtime and reducing costs associated with waiting for new parts. This approach, in turn, nurtures equipment sustainability and bolsters the pursuit of long-term productivity and profitability. In light of these findings, further exploration and innovation in this evolving landscape hold significant potential, promising to reshape the dynamics of consumer behavior, sustainable practices, and operational efficiency within the construction equipment domain.

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