International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 06 - Issue 04 || April 2021 || PP. 27-32

A Review of Fraud in the Remanufacturing Industry Based on its Source

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Abstract: Warranty frauds in the new product industry have been well covered in recent literature, however, fraud issues in the remanufacturing industry have only recently been explored in a meaningful way. There are many ways to categorize these fraud problems. This paper attempts to do so by examining their point of origin. The paper highlights the various unique opportunities that exist for each of the parties when it comes to committing said frauds. Additionally we discuss the philosophy on how to approach cases of fraud. Lastly we discuss the various limitations that tie down and restrict the hands of the warranty providers in tackling fraud.

Keywords: End-of-life, Reverse supply chain, Fraud, Remanufacturing, Warranty

I. INTRODUCTION

Environmental legislation has encouraged firms into moving away from disposal and more toward end-of-life (EOL) strategies. By keeping waste to a minimum, these firms can reduce disposal costs, boost profits, discover new business opportunities, and protect and improve the state of the environment. One of the more prominent EOL strategies that have achieved success in the United States is remanufacturing. Remanufactured products are built with the purpose of being market substitutes for their manufactured counterparts. The availability of low-cost high-quality products has resulted in a steady increase in the size of the remanufacturing sector globally. However remanufacturing still faces obstacles in certain markets for a host of reasons, one of which is customer perception that a remanufactured product is unable to perform as well as its normal counterpart. One business strategy that has proven to be effective in combating this mistaken perception and attract customers is to bundle remanufactured products with extensive product warranties. The integrity of the warranty supply chain of a remanufactured product is therefore of utmost importance, as disruptions to these operations may result in a host of undesirable outcomes which may range from revenue loss to extensive product recalls. Fraud is an overlooked issue in both manufacturing and remanufacturing environments. Much research has been undertaken to understand the issue of fraud from both a psychological perspective as well as an engineering problem. That being the case, there is no universal methodology or tool available in dealing with fraud, as the options available to the victim depend heavily on the relationship between the fraud victim and the fraud purveyor. Frauds in the new product industry have been generally well covered in recent literature [1-3]. However, issues of fraud in the remanufacturing industry have only recently been covered. This study models the issue of fraud in a remanufactured product warranty servicing scenario, where the warranty provider (WP) is the primary victim. Fraud can originate from any entity in the warranty service chain and as such we consider those scenarios where the fraudulent entity has a subordinate relationship with the WP, such as third party service agents, parts providers, and local administrators; and cases where they do not, such as customers and shareholders. In light of these relationships, any actions that curtail frauds may be limited in some cases but ample in others.

II. LITERATURE REVIEW

2.1. Reverse logistics

EOL activities are most often carried out by the product manufacturers themselves. To facilitate the return of large numbers of consumer products back to their origin requires a capable reverse logistics (RL) network. The systemic problems and issues that exist in RL have been reviewed in recent literature [4]. Many case studies have examined RL problems involved in consumer product maintenance and product EOL. Similarly, a number of papers [5-7] examined case studies that aimed at optimizing RL networks. Issues in RL from the perspective of EOL were tackled by many researchers including [8] and [9]. Reverse logistics encapsulates many different activities, which also include remanufacturing and refurbishing related processes. Because of misconceptions held by consumers, remanufacturers often search for market mechanisms to encourage consumers into purchasing their products [10].

2.2. Warranty as a marketing strategy

The majority of the extant literature was focused on warranties with respect to the new product industry. More recently, many of the same types of issues have also been tackled in the remanufacturing sector.

One case study [10] described a two dimensional warranty policy where the objective was twofold i) to maximize consumer confidence and ii) to minimize the cost to the remanufacturer. An optimum marketing strategy for maximizing profits should include considerations such as pricing, warranty service, and production [11].

2.3. Warranty Fraud

In the past, statistical fraud detection methods have been useful in handling fraud. Widely used statistical classification methods such as linear discriminant analysis and neural network methods have been shown to be effective tools in such supervised situations [12, 13].

The most prominent types of fraud are insurance frauds, financial frauds, and business frauds and the type of frauds that they deal with are distinct and may offer clues as to how to solve remanufactured related frauds. A recent literature review examined research that focused on how fraud is dealt with in other industries [14]. Based on this literature review a number of conclusions and parallels were drawn. It was noted that the warranty service chain for remanufactured products bears certain resemblances to the service chains for the other industries examined in the review [14].

III. DESCRIPTION OF THE SYSTEM

When a warranty provider offers a warranty on a remanufactured product to a customer, there are a host of other parties that are also involved in the service and thus may also be involved in any potential fraud. The various parties can be separated into one of three categories (Table 1).

Table 1: Parties in a warranty servicing chain [15]

Categories	Parties
Primary	Warranty provider, Service agent, Customers
Secondary	Parts manufacturer, sales channel , Warranty administrator
Tertiary	Leasers, Inspectors, Logistics companies, Underwriters & Insurers, Government, Shareholders

In a typical warranty service system, when a product is rendered nonfunctional, it is inspected to determine the cause of failure. The information about any such failure is transmitted to the service personnel (third party) who conducts the required service operations; for example, replacing the failed component or components. After this process, failed products are transferred to the service facility. After the maintenance process takes place, the products are brought back to working condition. Once the maintenance service operations are complete, the products are returned to the customers. Fig. 1 describes the information flow between the key parties in a typical remanufactured product warranty service [12].

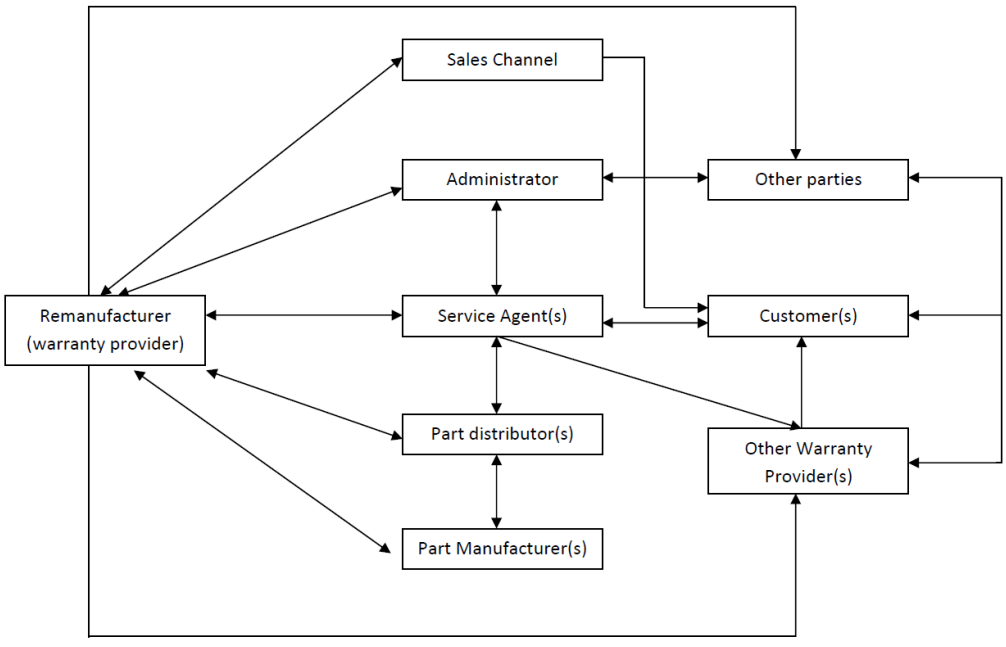

Figure1: Key parties involved in a warranty servicing chain

IV. CATEGORIZING FRAUD AGAINST THE WARRANTY PROVIDER

Fraud is a very large research topic and many of the issues surrounding fraud have been enumerated and expanded upon, however in order to narrow down the scope of fraud only the fraud against the warranty provider (in this case the remanufacturer) are being considered. This section describes the scale of fraud and its effect on the warranty provider.

4.1 Fraud from primary parties

The different types of fraud that a warranty provider may have to deal with originating from the primary parties are outlined in table 2. While fraud can have a significant impact on a company's overall profitability, its effects often manifest themselves in different ways.

Table 2: Fraud considering both the motivation and method (primary)

Fraud Source	**Motivation**	**Method**
Customer	Refund or replacement	Unjustified return or replacement of item that is not faulty or is a fake
	Service cost avoidance	Getting out of warranty products repaired under warranty
	Extra products or earning	Claiming and reselling parts or replacement items
	Service level improvement	Claiming better service than being entitled for
Service agent	Extra revenue	Creating fictitious claims
	Extra revenue	Intentionally conducting out of warranty service at warranty providers expense
	Extra revenue	Inflating the price of an existing claim through various methods
	Extra revenue	Intentional overselling or use of too many parts
	Extra revenue	Using or reselling warranty provider owned parts obtained by unnecessary claims disassembly , or returned products
	Service cost avoidance	Using counterfeit or unauthorized parts or products
	Service cost avoidance	Not doing all the necessary actions under the service contract
	Service cost avoidance	Unnecessarily changing parts to minimize diagnostics effort
	Service cost avoidance	Using unqualified technicians to reduce costs

4.2 Fraud from secondary parties

The secondary parties also have a role when it comes to fraud. These parties include the Warranty administrator and service channel. There are a number of unique scenarios that can exist mainly due to the position that these parties occupy in the WSC and responsibilities that they have. Warranty administrators are in control of service agents and their claims. They make decisions on claims to be approved and rejected and thus determine the value of the payment to be made to the service agent within the boundaries set by the warranty provider. Warranty administrators can also set up vendor master data and price data as the basis for service agent compensation. They can also make decisions to allow customers a refund, replacement, or repair as a part of the RMA process. As representatives of the warranty provider, warranty administrators have the power to make decisions with financial implications. This power can also be abused. Additionally since they are ostensibly in an oversight position there are no parties that are responsible for their regular oversight. For these reasons dealing with fraud from the warranty administrator poses a complex problem. Similar problems exist with regards to the sales channel. Table 3 lists the different types of warranty fraud originating from the secondary parties.

Table 3: Fraud, considering both the motivation and method (secondary)

Fraud Source	Motivation	Method
Sales channel	Extra revenue	Scanning serial numbers and customer information from sold items to enable fictitious claims*
	Extra revenue	Selling warranty assets
	Cost avoidance	Charging the cost of extended warranties to the OEM
	End customer satisfaction	Providing out of warranty repair/refurbishment for good will and charging the OEM
Warranty administrator	Extra income	Consciously not doing entitlement /claim validation properly
	Extra income	Approving invoices that exceed the claimed amount
	Extra income	Applying inflated prices in calculation of SA compensation
	Extra income	Generating and approving fictitious claims from fictitious service agent
	Minimization of effort	Consciously not doing entitlement/claim validation properly

4.3 Fraud from Tertiary parties

Based on the literature review, the study determined that rather than being a source of fraud, the tertiary parties are more often on the receiving end. Most notably, warranty providers can utilize their expense statements to manipulate their income statement and defraud the government out of tax revenue and may manipulate the shareholders view of the firm's profitability. If the definition of fraud is extended to include instances of actions taken by a party that negatively impact the warranty provider, regardless of intent (the traditional definition requiring either malicious intent or personal incentive), then we can judge actions such as government legislation (most often environmental) dictating stricter requirements which intern affect remanufacturer profitability or pressure from the shareholders to achieve better profitability etc. as being fraudulent activities. However for our study we adhere to the more traditional definition of fraud and exclude such activities from consideration.

V. TACKLING FRAUD AGAINST THE WARRANTY PROVIDER

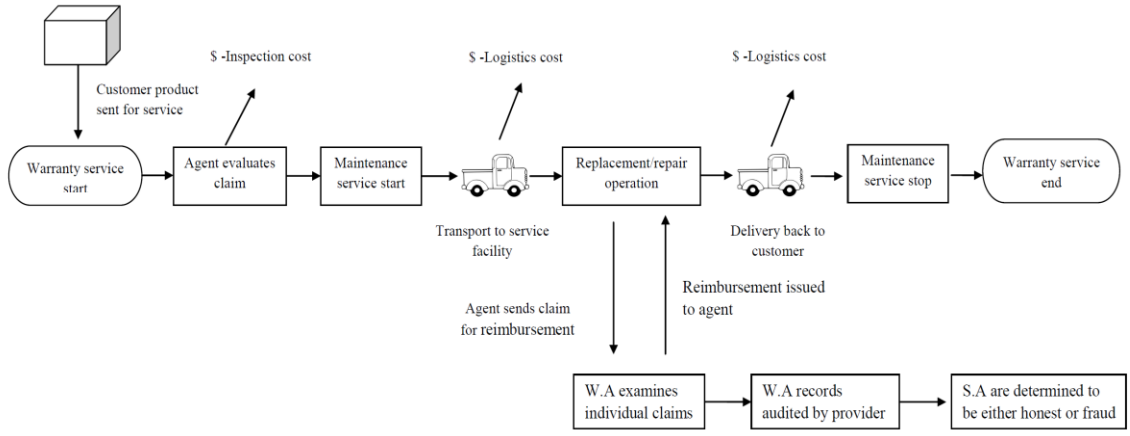

Figure 2: Warranty servicing with claim validation

Dealing with frauds affecting the primary parties presents varying challenges. If the fraud source is the service provider, the audit of claims (figure 2) mirrors the same steps as for the review of claims in the health care and automotive field, and as such data mining and neural network methods would present the best way of dealing with such frauds. Similarly, if a service agent overcharges a claim, methodologies (anomaly detection) that are employed in the financial sector would assist in monitoring such frauds. If the source of fraud is the customer, the process of assessing the validity of a customer's claims is comparable to that of the health care and automotive industry and it follows that similar techniques would be effective.

The study considered numerous fraud scenarios and checked compatibility against various fraud modeling and detection techniques. It was determined that there was no "one size fits all" methodology that would properly encapsulate the problem. The merits of certain techniques, some that were not covered in the review were also noted. With regards to fraud modeling, game theory was shown to be useful in determining a party's (players) optimum decision given the payoff (fraud amount) [16]. One study [17] used Nash equilibrium to contrast the optimum decision between the remanufacturer and the service agent for an overcharging warranty fraud scenario and examined the relationship between fraud amount, penalty value, inspection cost, and player risk. Discrete event simulation was also shown to achieve some measure of success in properly recreating the fraud scenarios and was also the most easily adaptable to fit new scenarios. This was shown to be the case when a fraud model developed in order to model service agent fraud [18], was able to be adapted to simulate customer driven fraud as well [19]. As with many other industries, the Internet of things (IoT) shows the greatest promise in both fraud detection and prevention. Past studies have shown the usefulness of sensor implementation [20] in dealing with disassembly line quality issues and this would also extend to fraud detection (location data, temperature data, etc., which would assist in determining if a product was actually serviced and or used within recommended guidelines). A theoretical model was proposed by [21], which considered the benefits of incorporating sensors into products would have with regards to reducing maintenance service times and inspection costs. It should be noted that these studies operated under the assumption that IoT and sensor embedded systems themselves could not be defrauded. A study by [22], which attempted to use a neural network model in a remanufactured product warranty scenario, noted that the main hindrance to researching remanufactured product fraud is the lack of readily available data sets to conduct said research.

VI. CONCLUSION

Fraud is sometimes an overlooked issue in both manufacturing and remanufacturing environments. This paper described some of the literature surrounding the issues of fraud and warranties in the remanufacturing sector. This review showed that it should be the goal of any responsible manufacturer to tackle the issue of fraud in the warranty service industry. The different types of fraud that affect the WP, based on their points of origin, were described emphasizing their methodologies and motivation. The problems in dealing with certain types of fraud as well as current and possible future methods in combating fraud were laid out. The use of discrete event simulation was found to be useful in tackling cases where there were multiple fraudulent players acting in partnership.

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