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Reverse Logistics for Malaysian Tire Industry: A Conceptual Framework for Strategic Implementation

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Abstract

The deficiency in product performance of tire which concerns safety issue requires an immediate pull back from the market. An increasing trend of defect tires pull back from the market has made enforcement of environmental legislation to be more forceful and that is one of the reasons tire manufacturers scouting for possible distribution channels or methods to enhance reverse logistics as part of their supply chain. In order to provide a conceptual strategic implementation direction, this research adopted qualitative method occupying in-depth interviews with major tire manufacturing companies in Malaysia to extract the data and explore resulting themes. A strategic model of implementation of reverse logistics for tire industry in Malaysia has been established as a guide for academician, practitioners and relevant regulatory bodies with an aim to improve the process of reverse logistics addressing cost structure and environment issues as well as to introduce and enhance the possibility of reverse logistics in the supply chain of tire industry in Malaysia.

Keywords: *Supply chain management; Logistics management; Reverse logistics; Tire manufacturing,*

1. Introduction

The past decade has witnessed critical attention from various organizations when it comes to an issue of processing a product or managing the material returns as a key component within the logistics activities. This can be attributed to a growing trend and increasing volume and monetary value of product flow in the reverse direction within the supply chain. In particular, such trends are observed when there is unavoidable yet growing legal pressure in relation to environmental compliances while fulfilling customer demands in the marketplace. Due to this pressing requirements, firms or organizations has started to scout for possible distribution channels or methods for the return of their product and this requires these organizations to adopt reverse logistics [1].

While logistics is about bringing forward the product from origin to customers, reverse logistics moves the product back from customers to the origin. [2] defined reverse logistics as a systematic process by the manufacturers who accepts returns of products from the end user point of consumption for the purposes of remanufacturing, recycling and in the worst case to dispose it. This definition was further strengthened by [3] who indicated that it is a strategic management a process which involves, planning, implementing and controlling of raw materials flow, work in progress inventory, finished goods with an efficient cost control measures with two ultimate objectives: i. to recapture the value, or ii. dispose it according to its standard procedures. This activity includes all pertinent information from the point of consumption to the point of origin which are essential to meet one of these objectives in the process of reverse logistics.

Rapid developments of the Malaysia automotive market, apart from indisputable advantages, bring about a range of problems including an increase in the amount of defected tires which requires proper disposal processes taking into account its implications to the environment if it is left unattended. Therefore, it is crucial for the tire manufacturers to develop a systematic and sound system such as reverse logistics that allow them to collect the defected tires for appropriate recovery operations. In spite of the importance of the reverse logistics significance to the manufacturers, the actual practice and its efficiency is found to nothing near ideal situation and that the system itself is unable to cope with many challenges throughout the supply chain such as transportation cost, storage cost, waste disposal cost and recycling cost associated with handling of the returned tire. The present study is an attempt to signal these challenges and attempt to propose possible recommendations.

2. Background

Malaysia has witnessed a vehicle production growth of 4.5% over a period of five years between 2012 and 2016 (i.e. 1.11 million units in 2012 to 1.16 million units by 2016). It was forecasted this growth will continue in the future and it indicated the potential developments in Malaysian tire market. According to Malaysia Tire Market Forecast and Opportunities, 2012 – 2022 report released by [4] in 2017, Malaysian tire reported a market value of $1.25 billion in 2016 which was then expected to hit $2.26 billion by 2022, enjoying a CAGR of 10.5% over a period of six years. It was also reported this growth will be facilitated by various sectors including automotive with growing demand for vehicles, infrastructural developments apart from forecasted increase in consumers' purchasing power.

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The increase in tire demand also contributes to the increase in the number of defect tire in the market. These defected tires are required to be withdrawn from the market taking into account the safety requirements. Therefore, a proper mechanism is needed to ensure a systematic return of these tires to the manufacturer. Nevertheless, establishing a sound mechanism poses several challenges to the manufacturers. While burning the defected tires is a common method of disposal, one can never discount the emission of ultrafine particles that have toxicity which causes air pollution and ultimately results at non-compliance to environmental standards hence, non-conformance to environmental rules and regulations. This action could trigger the society in general and the regulators and environmental activists in particular with an ultimate implication of financial penalties as well as adverse image and brand damage to the tire manufacturer. Thus, the tire manufacturers are forced to find an appropriate solution in handling the returned tires in the most efficient way with least impact to the environment. Understanding the current practices of reverse logistics among tire manufacturers and proposing value creating and capturing processes within the supply chain will be the focal point of this study.

3. Organizational and Managerial Aspects of Reverse Logistics Process

The implementation of reverse logistics in the tire manufacturing requires an appropriate design and efficient system to control the whole process. For this purpose, the execution of tire reverse logistics must be supported by strategic, tactical and operational decisions (see Table 1). Thus, the following factors should be considered in the decision to implement reverse logistics process in the tire industry [5]:

- The existence of forward logistic process which allow the reverse function.
- The availability of technology for the recovery process and etc.
- The recovery option (recycling, re-manufacturing or reuse) that will be applied to the returned product.
- The purpose of the reverse logistics system.
- The size of the company and its business objectives.
- The structure of the distribution channel.

3.1. Organization design

There are many aspects to be considered in implementation of reverse logistics. However, entity determination and also design of the scheme remain most essential aspects that requires critical attention. As presented in Table 2, reverse logistics can be developed on a diverse scheme by the organization itself or by a third-party company. Depending on the objective of the reverse logistics process, the management of reverse logistics can be performed as follows:

3.2.1. Organization Execution

In this case, the tire manufacturer designs, manages and controls the recovery and reuse of its out-of-use products. They generally own a complex and advance technologies in the recovery process of the added value. (e.g., Design for the Environment—DFE, Design for Dismantling—DFDA). However, some part of the process is outsourced to third parties. The logistics network design in this type of process is generally complex, multi-link network, and decentralized in which the recovered product is reintroduced into the original closed-loop Supply Chain (SC).

3.2.2. Third-Party Execution

In this case, the tire manufacturer outsources the responsibility to manage the recovery process to third-parties. While considering third parties, commonly the manufacturers are given two options. The first option allows the manufacturers to participate in Integrated Management System. On the other hand, these manufacturers are also having the next option of hiring professional services from logistics experts who are able to not only offer reverse logistics services but also enable the manufacturers to realize the benefits of its implementation.

There are many schemes that can be considered by tire manufacturers as a starting point in the designing of reverse logistics. These options are tabulated in Table 2. In order to achieve this, the participation of government, environmental activists and the society is crucial to ensure the successful establishment of adoption of reverse logistic process.

While each design has its own strengths, it also suffers several weaknesses in actual practices. Some of the significant deficiencies include the followings:

- Competitive advantage is not recognized as an outcome of reverse logistics.
- Absence of proper bridging between internal processes, external processes and associated processes in dealing with return of products within the supply chain.
- A belief that products which are returned through reverse logistics do not have significant implications in terms of cost, revenue and also asset valuations.

4. Reverse Logistics Strategy for Returned Tire

Adoption of reverse logistics through the return of tires is found to generate environmental benefits and economic value across various areas and stages of implementation. In order to understand these implications, two strategies are chosen to be discussed further namely remanufacturing and diversification. The following section will offer a discussion about these two strategies.

4.1. Re-treading Strategy

The adoption of this strategy will ensure less impact to the environment while recovering the value of the tire which would otherwise end up in landfills. It was found by [5] that this strategy will result a significant savings in energy demand in production capacity and materials during the manufacturing process (i.e. 66 per cent). This is eventually expected to increase the life span of a tire between 75 per cent and 100 per cent from a new tire depending on retreading process efficiency and quality.

4.2. Diversification Strategy

This strategy will create an opportunity to close the Supply Chain loop by generating a new product or raw material for other processes within the company (or to open a channel with new business). Among the product resulted from this strategy are tire dust, steel and the textile fibers.

5. Challenges for Tire Reverse Logistics

Tire industry is not an exempt to various challenges when it comes to implementation of reverse logistics [6,7] highlighted several challenges which make tire manufacturers to be hesitant in having them involved in the process of reverse logistics.

Table 1: Strategic, Tactical and Operational Decisions during Reverse Logistics

Activities	Strategic Decisions	Tactical Decisions	Operational Decisions
Waste Collection	(a) location, quantity and capacity of collection facilities; (b) design of technologies for collection	(a) transportation of waste for collection centers; (b) management of collected waste inventories; (c) means of transportation	(a) collection routes; (b) collection lots; (c) load configuration
Inspection and Classification	(a) location, quantity and capacity of facilities for classification and inspection; (b) training of personnel	(a) inventory management of recoverable products; (b) task assignments; (c) sequencing of tasks: disassembly, cleaning, repairing	Option 3-R to be applied: reuse, re-manufacturing, recycling.
Economic Recovery	(a) technology; (b) effects on the long-term Production Plan	(a) effects on the aggregate Production Plan; (b) recovery lots; (c) management of inventories of recovered products	(a) effects on the Master Production Program; (b) Bill-of-Materials
Distribution	(a) distribution channels; (b) target markets	(a) assignment of products to markets; (b) means of transportation	(a) distribution routes; (b) distribution lots
Elimination	(a) removal systems; (b) target products to be eliminated	(a) management of inventories of non-recoverable products; (b) means of transportation	(a) handling of waste

Source: Santiago *et al*. (2018)

Table 2: Management schemes of reverse logistic systems according to the developing entity

Scheme	Company	Third-Party: Integrated Management System	Third-Party: Logistics Professionals
Business	(a) Market leader; (b) Environmental strategy; (c) Dominant SC position	(a) Small and medium-sized enterprises; (b) Collaboration with other members of the SC	(a) Subcontracted direct logistics flow; (b) Development of the scheme for operational reasons: returns, toxic or hazardous waste
Product	(a) Very differentiated; (b) High added value; (c) Advanced technology; (d) Complex structure	(a) Little differentiated; (b) Low added value and residual; (c) Low technology; (d) Design for Recycling (DFR)	(a) Diversity of products; (b) Obsolete, defective, damaged, toxic or dangerous
Process	(a) Multiple tasks; (b) Intensive labor; (c) Very relevant transport	(a) Complex process; (b) Advanced technology; (c) High initial investment	(a) Simple process; (b) Few tasks; (c) Intensive labor
Market for Recovered Products	Same market as the originals	Different market than originals	(a) Share market in reuse; (b) Distinct market in returns
Network Design	(a) Integration of direct and reverse flows; (b) Decentralized and complex; (c) Closed-Loop; (d) Subcontracted activities	(a) Open Loop; (b) Centralized; (c) Simple with few levels; (d) Significant transport	(a) Open-loop on returns and closed-loop on reuse; (b) Simple and decentralized; (c) Significant transport
Reverse Scheme Goal	Recover elements of high added value	Regulatory compliance on waste	Regulatory compliance on waste and guarantees of consumption
Management Option	Manufacturing	Recycling	Reuse and Returns

Source: Santiago *et al*. (2018)

5.1. Regulatory Compliance

A comprehensive knowledge and understanding of laws, regulation and processes in regards to waste management is essential. It also underlies the philosophy of an organization in inculcating corporate social responsibility elements within their reverse logistics concept adoption and implementation. This is evident in many countries where the organizations are held accountable for entire supply chain of waste disposal including selection of an appropriate waste disposal methods in the course of manufacturing and also distributing their products to the marketplace. European Union will be one of the prominent examples showcasing such accountabilities.
Uncontrolled burning of waste tires leads to serious public health and environmental threats. Since tires are not made from biodegradable components, it needs to be recycled rather than to be disposed of. A rising number of illegal tires dumping invited open burning that harms environment. Smoke from the open burning accumulates dust and emits toxic gases. This toxic gas is dangerous and poisonous as it may find their way into several elements such as soils, water, enter the food chain and subsequently living in the tissues of plants, animals and human beings. Their effects on the environment and human health have been well established and well known by everyone and regulations also had stated that open burning is an illegal activity that should be avoided by everyone [8]

5.2. Lack of 3PL Provider in Reverse Logistics

While the supply chain of reverse logistics does not end at the manufacturers alone, concerns remain on how to integrate other partners such as retailers, dealers and distributors within this supply chain. This was evident in a study undertaken by [9]. According to them, garnering support from the partners cannot be discounted in the reverse logistics supply chain and that gaining their support for successful adoption and implementation of reverse logistics remain a crucial challenge. Such hesitation can be attributed to the lack of commitment of these partners as they tend to perceive negatively about the intention of customers in purchasing remanufactured products.
However, the major aim of companies such as shippers and third party logistics service providers is to reduce any costs contribute by gaining more profits, which may not correlate with the environmental concerns and issues. Therefore, governmental policies or industry interference may be needed to secure positive environmental friendly outcomes.

5.3. Management of Reverse Logistics Costs

[10] cautioned that a reverse logistics process is very labour intensive which generally enjoys very limited process automations. It can make up about seven per cent to eight per cent of cost of good sold. These costs may consist of transportation cost, storage cost, handling cost and disposal and recycling cost. Since these costs are rather high for an organization, execution of reverse logistics requires a stricter expense management so that it does not cause harm to the bottom line of the organization.

5.3.1. Transportation Cost

Transportation cost is one of the most debated costs in distribution management. It becomes even crucial when an organization considers adoption and implementation of reverse logistics. A proper transportation service is required to be in place to ensure efficient collection and disposal of defected tires which may come from various locations. Hence, the availability of the transportation services always has been a major concern to the tire manufacturer due to inconsistencies in the volume and resulting revenues to attract the third party logistics services providers as compared to forward logistics for the same products. Hence, it can be anticipated that the cost of reverse logistics operation to be relatively higher than forward logistics. Nevertheless, an efficient design and implementation of forward logistics and reverse logistics should contribute to the entire logistics network optimization which eventually should be able to control transportation cost in reverse logistics process [11].

5.3.2. Storage Cost

Limited capacity is a common issue of reverse logistics that arise for many companies and manufacturers. [12] stated that overall logistics performance can be been affected due to the additional cost by compelling factors which are unplanned. The storage costs of the returned good stresses the organizations because these are not the total costs of returns, since transportation costs and inventory holding costs are not included. In fact, the total costs of handling returns are much higher when costs associated with transporting, and handling in stores are included.

5.3.3. Handling Cost

Handling cost is one of the costs involved in the reverse logistics process. It requires manpower and equipment that are devoted from the normal process to arrange the return tire for the next process. Knowledge of the methods or practices used in receiving, handling and delivering any products is essential as it indicates company's performances.

5.3.4. Waste Disposal and Recycle Cost

A lot of manufacturers decided to postpone the adoption of reverse logistics considering the costs associated with necessary infrastructure and equipment in collecting end of lifecycle waste. The cost involved and the idea of whether to recycle or reuse the product is one of the main concerns in implementing reverse logistics [13]. In recycling, each of return products requires a different kind of disposal method depending of the type and nature of the product being collected. These variations in processes and methods of disposal result at large amount of cost which is to be considered by the company. This cost is found to be much higher if the company has decided to opt for disposal approach [14,15].
Nevertheless, with the passage of time, it is important to overcome these challenges in order to capitalize on the available resources in the most effective manner [16].

6. Perceived Benefits of Reverse Logistics

Many researchers have outlined the key reverse logistics elements that can either positively or negatively impact a company's performance. [15] stated that the main benefits of doing reverse logistics enables creation of competitive advantages in business by increasing efficiency and productivity. Forward logistics deals with flow of goods from the point of origin to the end users. In contrary, reverse logistics undertakes activities which return the parts, materials and products to the point of origin from end users for various reasons. These activities usually involve several aspects. Among others, product recalls, value and warranty recovery, repair and redistribution and many others.

7. Research Approach

To provide a comprehensive base for the analysis, this study was done based on the data collected from qualitative method using in-depth interviews with the selected tire manufacturer companies. A set of questionnaire was prepared based on the previous study as a guide or the interview session. To comply with research ethic and to gain quality responses, the researcher has selected the respondent who has knowledge in the operation of the tire business. Using the

saturation principle, 6 tire manufacturers have been interviewed to extract the research theme. The data were analyzed to identify converging or diverging areas of interest.

8. Discussion on findings

Based on the information collected during the interview, we developed a conceptual framework of the reverse logistic process for a returned tire (see Figure 1). The construction of this conceptual framework allowed us to understand the sequence of reverse logistics practices adopted by the tire companies in Malaysia. The framework indicated that tire companies and the third parties involved in the reverse logistics process for the returned tire were based on their core competencies. The tire company that owned the tire technology will focus on retreading process while the third party will focus on reuse (shredding) and recycle (pyrolysis) process which they have competitive advantage in term of expertise and technology. This is in line with the finding [17] in their study who suggests that utilization of third party logistics service providers will enable reduction of environmental costs and secure profits through an efficient operation. Tires that go beyond repair process will be sold to the third parties for the next process in the supply chain.

One important observation in this framework is that the disposal process is not occurring in the case of Malaysia. The entire returned tires will be retreaded or being sent for shredding and pyrolysis process due to enforcement of prohibition of tire disposal at a landfill site since 2006.

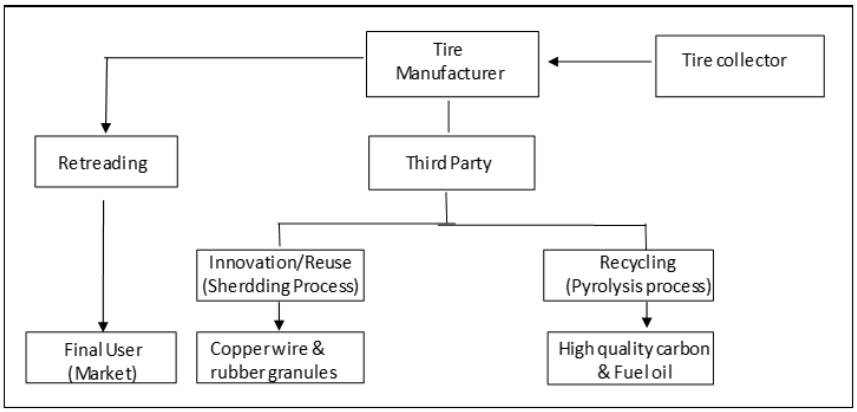

Fig. 1: Conceptual Framework for Returned Tire

This study investigated and recommended a framework that integrates several constituents in an attempt to implement reverse logistics in the tire industry. As an outcome of this qualitative research, some of the influence factors which encourages or discourages adoption and implementation of reverse logistics in the tire industry in Malaysia is concluded and depicted in figure 2. While cost and environmental factors were widely discussed in the past literature, this study found new business opportunity as another driver that motivates adoption and implementation of reverse logistics to the organization or third party logistics service providers.

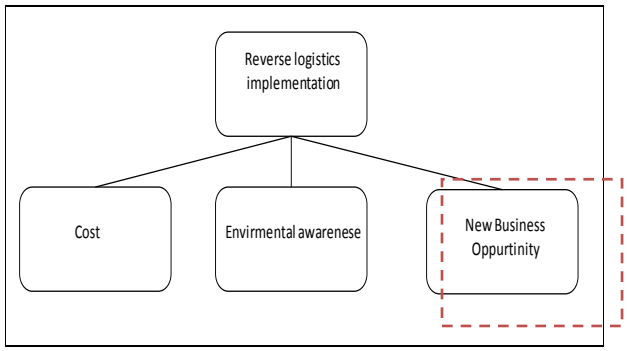

Fig. 2: Influencing Factors of Reverse Logistics

In the current business environment, the management of cost has been always a top priority in the company agenda. The success in the implementation of reverse logistics largely relies on how the tire manufacturers increase the utilization of resources and optimize existing logistics set up at a competitive cost. One of the significant costs in reverse logistics is a transportation cost which incurs during the collection and selection process for delivery to the next supply chain process. A study by [18] had concluded that transportation cost contributed significantly to the total reverse logistics cost which is why these serves are generally outsourced to a third party logistics service provider. Other than transportation, the tire manufacturers also have been facing storage and handling costs. Additionally, a huge amount of returning tires requires sufficient space for storage.

The importance of environmental and health awareness can be seen in the most of the tire company policy which is a motivation for the management to implement the revere logistics. The demands for implementation of reverse logistics in the tire industry is increasing because of massive tire dumping activities in land filling area which act as a good breeding ground for mosquitoes and insects that leads to the spread of disease such as dengue. The tires open burning in some areas also emits toxic gases and smoke in the air. By doing reverse logistics, tire manufacturers can reduce tire waste by capturing another value from the tire using recycle and innovation process. A study by [15] proved that recycling is more than just an issue of economics and is essential towards the care for human health and environmental sustainability.

A lot of new business opportunities have been created from the reverse logistic process. The tire manufacturers company has partnered with the third party companies to process the tires that are beyond than repair. These tires are recycled into copper wire, carbon black, fuel oil, rubber granules and other rubber products for other supply chain processes. An increasing number of the third party company in tire reprocessing industry has created job opportunities and income to the tire company and tax to the nation. [17] study stated that utilizing 3PL providers reduce environmental cost and secure profits through an efficient operation.

9. Conclusions

The study defined a conceptual reverse logistics model for the returned tire in Malaysia due to an absence of work and consensus regarding reverse logistic strategies in this country. For this purpose, a review of tire waste management strategies in recycling and sustainable practices was performed.

In this study, two specific reverse logistics processes were related to returned tire: re-manufacturing and diversification, as a means to make a tire waste management system economically accessible and

sustainable. These processes were integrated within a reverse logistics model considering the most standard processes performed in the developed country where the tire company is partnering with the third party to participate in the process. Although a better strategy over the reviewed strategies cannot be assured due to the different regional conditions of financial mechanisms, regulations, involving entities and technologies established in each country, within the context of Malaysia the proposed model can provide guidelines to incorporate re-manufacturing and diversification in their waste management systems as no previous works concerning this country have been reported.

In developed countries, the returned tire is not limited to the process discussed earlier. A more sustainable and economically friendly solution has been introduced in the US which known as Devulcanisation. In Malaysia, tire industry is still not exercising and implementing this method because of a few hindrances. This method involves breaking the bonds that hold the individual polymer chains together and create a network. There are different methods to break the bonds including using chemicals or microwaves, and biological and ultrasonic methods. A study by [19] stated that this method extracts, save more virgin rubber as end products and it is more eco-friendly to be compared with the adapted method in Malaysia. The process involved generates a host of problems and a great deal of research being made to solve them. This includes finding ways to reduce the amount of chemical used. As the cost of chemicals involves in practicing this method is high, Malaysian tire manufacturers are not implementing this method in managing the scrap tires. Furthermore, there is no partnership company has been set up in testing the method for Malaysia tire industry.

All companies in tyre industry can upgrade their technology to support reverse logistics process. The use of automatic consolidation of data can easily link all partnered companies working together in a supply chain. Certainly, one of the most effective solutions improving the operation of the system of reverse logistics of worn tires would be the application of RFID technology and placing the RFID label in each manufactured tire. This would allow the tracking of a tire at every stage of its use, also after withdrawing from use, which would significantly increase the efficiency of collection. However, such solution seems to be impossible to apply at present, most of all, due to the costs of its implementation by establishing the automatic consolidation of data, all tire companies can give authorization to a single collector from waste management company for managing the reverse logistics process from collecting the tire until recycle it. This adoption can improve the efficiency in reverse logistics as tire manufacturers can focus on their main business and they can save a lot of transportation cost.

This study has been carefully conducted and provided valuable information for the implementation of reverse logistics in the tire industry. The process enables the relevant authorities and stakeholders to adequately consider effective technical options based on the manufacturer's ability to handle their returned and waste tires. Throughout this study, the awareness of tire manufacturers in Malaysia for the waste tires management is considered in a good level. The study concludes that in general, reverse logistics in tire industry played a big role in conserving the environmental and health condition and this activity also contributes to a better supply chain process which maximizing the life cycle of the tire and extract a lot of benefits from it. While there are misconceptions that tire recycling is too time consuming and costly, there are actually numerous methods in recycling the tires correctly. Furthermore, reverse logistics in the tire industry creates jobs and business opportunity, which helps the economy growth. By doing the right thing for the environment, community and future, tire recycling industry cannot be seen as just important but it is critical. Future research may refine the findings by identifying the best practices in implementing the reverse logistics for tire industry in terms of recycling methods.

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