Eco-Value Co-Creation Towards a Sustainable Tire Scrap Recovery Network: Case of Bridgestone Thailand

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Abstract—**Fast economic growth has currently been accelerating demand for automobile technology although scrap tires are improperly managed. Many discarded tires cause adverse impacts to the environment, social, and significantly affect to public health. Due to many growing concerns on environmental conservation and human well-being, sustainability has become a main focus of industries, including the tire one. The Extended Produced Responsibility (ERP) Directive is another challenge for tire manufacturers to constitute an end-of-life (EOL) management system to promote collection, recycling, or reusing of EOL tires. Thus, it is essential to have an effective tire scrap recovery network to properly manage all the used tires in sustainable way. Not only does this paper show cooperation of tire manufacturers, distributors, recyclers, but also includes government agencies, private sectors, and end users for creation of integrated tire scrap recovery network. Achieving sustainable development for stakeholders in tire scrap industry, this study demonstrates an eco-value co-creation model based on a tripartite concept describing how value is co-created in service providers and recipient interaction along a scrap recovery network. The approach is taken by studying human aspects incorporated with expert opinions on tire scrap management and literature reviews and secondary data analysis will be thoroughly conducted.**

I. INTRODUCTION

Rapid economic, social, environmental, and technological changes have gradually unveiled unprecedented challenges to all mankind. Especially fast economic growth and technological advancement have currently caused accelerating demand in automotive industry although scrap tires are improperly managed [1]. Scrap tire disposal has become very controversial since the late 1970s [2]. The World Commission for Environment and Development has emphasized on the need for a sustainable future [3]. Economic, environmental, and social considerations are inseparable and must be deliberately applied to industrial practice and consumption patterns worldwide [4], [5]. Concern has been growing on surrounding environmental conservation and the quality of life of future generations; therefore, sustainable development has become a goal for many industries [6].

The amount of used automobile tires has exponentially been growing. According to reports from tire associations, the annual global tire production reached 1.5 billion tire units in 2012, which corresponded to an estimation of almost 20 million tons of tire scrap [7 - 10]. The scale of the problem magnified by the environmentally dangerous dumps has been seen in many border urban and rural areas. A vast number of discarded tires and dumps cause serious adverse impacts to the environment, social, and significantly affect to public health [1].

Due to many growing concerns on environmental conservation and human prosperity and welfare, sustainability has become a main focus of industries, including tire one. Governments and consumers have been pressing companies to reduce the environmental impact of their products and processes [11]. Many tire manufacturers have looked back to financially and organizationally responsible for take back their end-of-life (EOL) products. Another challenge for tire manufacturers to constitute an end-of-life (EOL) management system is the Extended Produced Responsibility (ERP) Directive to promote collection, recycling, or reuse of EOL tires. To successfully manage scrap tires, manufacturers should focus on having an effective tire scrap recovery network to properly manage all the used tires in sustainable way. It is important that the sustainable recovery network have a modern and relevant insight on of scrap tire situation along the chain in the relationship of environmental management and environmental economics.

Recovery scrap tire network is a service that manufacturers provide to consumers. Broadening the service concept, this paper focuses on a tripartite concept of the co-created relationship among related stakeholders, namely service providers, service recipients, and ecosystem. There are five groups of activities that appear to be recurrent in the recovery network: collection, inspection and separation, reprocessing, disposal, and redistribution [4]. Each activity needs corporation not only tire manufacturers, distributors, recyclers, but also government agencies, private sectors, and end users for creation of integrated tire scrap recovery network.

Services dominate the world economy, and thus they have a tremendous environmental impact. Broadening the field of service sustainability, this paper applies the tripartite value co-creation concept to tire scrap management. There are three essential components of service. First, physical evidence is the service environment and other tangible aspects of service that facilitates or communicates the nature of service. Second, participants are people who involve in the production of service. Third, process is the procedures and flow of activities [12]. Service activities require value co-creation between exchanging parties and a win-win relationship [13]. Environmental value for sustainability in terms of service is called, in short here in this paper, eco-value co-creation. In all processes across service providing activities, well-being

environment should be a core concern when values are co-created to all parties. For tire scrap management network, to create true eco co-created values, it is important that the whole life cycle of tire be sustainably managed. In shorts, eco-value co-creation is a broadened concept of value co-creation.

Thus, employing the tripartite concept will enhance collaboration of these parties. The tripartite concept is created to satisfy the needs of current providers and recipients to engage in mutual value co-creation without decreasing the quality of future value co-creation. It emphasizes on the importance of parties being shared in value co-creation. The three inseparable parties are service providers, service recipients, and natural capital. Service providers collaborate with recipients to improve mutual values and enhance the values of natural capital by creating a voice for nature in service process [14]. A service system should be sustainable and designed according with norms and values of a society by focusing on value co-creation among actors. Sustainability is one of the five global service trends. It links to increase collaboration and relationship among parties based on the concept of sharing co-created values [15]. The goal of sustainable service is to improve services in terms of safety, integration, economic, effectiveness, and efficiency. Material efficiency concept has been introduced to many manufacturing industries. This idea has also been applied to waste management services as environmental services [16 - 17].

In order to have an effective tire scrap management system, it is inevitable to study tire attribute and production amount whether they are produced on the basis of lessen environmental and social impacts. This paper provides a thorough review of performance, operation, as well as approaches of a scrap manufacturer. Tire manufacturers are an important key player that has very high impact on tire production. Throughout a lifetime of a tire, tire quality is the most important factor to concern as it affects tire performance and impacts that will have on the environment. Thus, this paper study on how a tire manufacturer performs on both tire production perspective and tire scrap management perspective. Also business environmental operation strategies and policies will be studied. The tire manufacturer that is used in this paper is the Bridgestone Group in Thailand. Bridgestone has been the world leader tire manufacturer and has strongly concerned on the environment. Having a sustainable recovery network is one of successful ways that leads to corporate sustainability. This paper aims to assess the interfaces and interactions of related stakeholders. This paper also aims to provide an analysis of current situation of scrap tire recovery network to verify the gaps along scrap tire logistics chain that challenge to network sustainability. Moreover, the paper will demonstrate an eco-value co-creation model to show how each actor in the network collaborates and creates innovative new value by incorporating human aspect and expert opinion on tire scrap management. To design such sustainable network, there is essential to take social, economical, and environmental considerations into account. To achieve the final goal, which is a better life quality standard, it is essential to maximize positive economical and social benefits and minimizing negative impacts to the society as a whole.

II. RECOVERY TIRE SCRAP NETWORK IN THAILAND

A. Tire production

The growth of population and economic recovery has paced up demand of automobiles. In accordance to that demand of vehicle tires has increased, Natural rubber is the main component of tires. Fortunately, with abundant natural resources, Thailand has been the world's largest natural rubber producing country. The rubber production has incrementally increased every year [26]. However, the more tires are produced, the more tire waste has generated. Thus, tire scrap management has been a big challenge for tire stakeholders. With less attention from the government, tire scrap management is not performing in a good stage. It is in an urgent need for appropriate and practical strategies.

With the rising use of automobiles, tire production has been increasing in every year. In 2013, there were almost 23 million tires sold in the country, this number accounts for 70% of total produced tires [27]. Over a vehicle lifetime, wear-out tires needs replacing for several times. It consequently results in a vast amount of tire scrap. In past decades, like in other developing countries, it was easily seen discarded tire scrap in many urban corners and rural areas. With enormously illegal tire scrap dumping, in the late 1970s, tire scrap disposal had become gradually controversial [2]. In 1980s, tire scrap has become valuable materials. Recycled tires can be used as raw materials for producing new tires [1].

B. Tire scrap management

The extended producer responsibility (EPR), a polluter-pays principle (PPP) based policy, was introduced in 1990s to deal with toxicity that came with increasing amount of solid waste [28]. In Portuguese, the government applied the EPR concept to tires. The system required that all stakeholders and infrastructure processes be identified and characterized [19]. The significant importance of the EPR was emphasized by the study of Driedger, which stated that among many policies the EPR contributed to promote reductions in consumer waste disposal [29].

There are two categories of tire scrap management; material recovery and energy recovery and several material recovery methods are also applied to tire scrap management. Regrooving is a technique suitable for tires that have original tread depth of 3 to 4 millimeters. Thus it is practical for truck tires. To make new treads, it can be done by taking rubber tire out in planned patterns. Although regrooving makes economic sense, it needs to be done with precautions [32]. Retreading is a process to extend tire lifespan. Tires will be prepared for regeneration by repasted tire surface and vulcanized again with new treads either by a hot or cold

process [33]. The technique is suitable for tires having passed inspection and have been certified to have no damage [10]. After each retreading, a tire will have a lifespan of 60%-90% of a new tire with 50,000 to 70,000 kilometers mileage [31]. Retreading is one of the most popular recycle techniques. According to the United Nations Environment Programme, retreading makes a big environmental contribution in terms of the more effective utilization of natural resources [34]. Product recycling is recycling whole tires in their original form without any physical or chemical treatment. Producing tire rubber powder or vulcanized rubber another method. Tires are grinded into well-dispersed rubber particles in different sizes with mechanical grinding technique. Vulcanized tire rubber power will be used as raw materials for new tires production, whereas bigger sizes are used as energy raw materials or as components of playgrounds or running mats. In terms of steel wire, it is removed by steel belt removal technique and later sold to steel processing plants [35]. Reclaiming is another technique for tire scrap management. Reclaiming of the tire scrap rubber content can be done with the use of oil, water, and agents. Reclaim rubber can be mixed with raw materials in producing new tires with limited amount due to its low quality specification [4]. Whole scrap tire can be used in many applications due to its endurance and elasticity. For example tires can be used as crash barriers, highway embankments, sound absorbing walls, bumper, artificial reefs, or foundation materials [36-37]. Moreover, products like handbags, wallets, belts, and footwear are made from tire scrap or inner tube scrap [38].

In terms of energy recovery, there are many techniques applied for tire scrap management. Shredded tires called as tire derived fuel (TDF) can be used as an energy raw material. Scrap tires have very high calorific value of 32 MJ/kg [39]. In Thailand, cement industry is the largest consumer of shredded tires. The shredded steel belts removed tires are mixed with coal or other fuels to be burned in cement kilns or paper mills [40]. Pyrolysis is another recycling technique, the thermal decomposition of tires in the absence of oxygen. Tires are pyrolyzed in special pyrolytic furnaces [41]. The productions of tires pyrolysis are fuel oil, steel cords, and carbon black. After being process, the valuable materials can be used as raw materials in many industries, namely petrochemical industry, steel industry, and rubber tire industry. Pyrolysis has gained very high attention from investors since oil prices were escalated. Thus this method of tire scrap management has substantially potential.

C. Tire scrap management models

As the growing concerns on environmental conservation and quality of life of future generations, there are more concerns on proper disposal of tire scrap [30]. Coping with growing tire scrap amount, there are three models widely applied to tire scrap management worldwide [10]. The first tire scrap management system is based on the EPR or Producer Responsibility Model (PR). According to this model tire scrap buyers or collectors will be asked to pay tire scrap management fee at the buying or collecting point. This fee will be transferred to tire manufacturers and recyclers as part of tire treatment process cost [31]. However, tire manufacturers or other parties that made tires available on the market have to ensure the legally required levels of recovery and recycling tire scrap. This model makes it more feasible to have a wide coverage of scrap tire recycling. It is over government control thus all processes are done more freely. However, public participation is less involved in this model [31]. The second model is free market and value tire scrap as profitability of recovery. Players can freely enter to the market based on market mechanism. There are no laws related to tire scrap disposal, storage, or transport. Also, there are no specific responsible parties or management roles identified. This model allows free competition in the market however it might cause harmful environmental impacts as players try to save cost by running low technology machines. This model is applied for tire scrap management in Thailand. The last model is tax system. In this model, additional disposal fee is added to the cost of a new tire disposal fee and is also added to the cost of a new tire and paid into the government budget [10]. Recyclers are responsible for tire scrap management. These recyclers are financed by the government fund from end users. This model is traceable since it is under control of the government. However, it can be a big task for the government and needs more resources for tire scrap management.

D Tire scrap management and a need for eco value co-creation – Thailand perspective

Countries have recognized the environmental impacts that have occurred and seemed intensify in the future. Thus, they have launched laws and policies to deal with these issues. Unfortunately, Thailand does not have specific legislation on control and management of tire scrap. The only legislation has been enforced is to control the amount of hazardous waste, which EOL tires are characterized in this category. A discharge pollution control measurement outside the plant is another hazardous waste or toxic substance control specified by the Department of Industrial Works, Ministry of Industry. This standard is launched to order every factory listed in the 106^{th} category to manage hazardous or toxic waste including EOL tires properly. However, there is no law to control the amount of tire scrap or to mandate a proper tire scrap management system in Thailand. Although tire scrap management in Thailand does not have a physical system or practical tire scrap recovery network, the situation has improved at some level. Tire scrap is rarely seen left unwanted as in the past. Private sector has paid attention on recycling technologies. Tire scrap recycle market becomes bigger as more players join to take potential business stakes. In Thailand, current stakeholders mainly involving in tire scrap management are tire manufacturers, dealers or wholesalers, end users, tire scrap collectors, and recyclers.

In current situation, each party does not coordinately work with one another. However, they do have some activities

related to tire scrap management. For example, the Thai Automobile Tyre Manufacturers Association (TATMA) founded as a non-profit association aims to promote the automobile tire industry by formulating and implementing policy based on safety improvement and environmental and economic effectiveness to contribute to the comprehensive development of Thailand's industry, economy, and the improvement of customers' welfare [42]. Tire dealers also offer options for end users on worn-out tires. Customers can either sell their old tires to dealers, leave them at the shop and get discounts for new tires, or take them home which is rarely seen and not recommended. Some groups of end users are more environmentally conscious while others more concern on price. Tire scrap collectors can be divided into three groups. First, manufacturers collect used tires from their retail shops or outlets back for reusing, recycling, or transfer them to cement kilns or recyclers. Second, dealers collect used tires for reusing or reselling as second hand tires. In Thailand there are many levels of dealer ranges from very large size dealers that provide all types of tires to small size dealers that scattered located on roadsides. The latter type of dealers stores very large amount of used tires and are the ones that end users easily seek for service. Third, recyclers collect used tires to be used as feedstock for their recycling processes. Recyclers, there are many types of recyclers doing business in Thailand tire scrap market. They are classified based on recycling technologies. Thus, there are recyclers can be cement manufacturers, fuel producers, or crumb or pulverized rubber producers.

Fig.1: Eco-value co-creation tire scrap recovery network model

In terms of service sustainability concept, it is essential that service providers and service recipients mutually co-create values based on their value-in-use of tire scrap recovery network [48]. Value-based service is value linked to other values is understood as co-created among both service providers and service recipients [49]. Looking in terms of service ecosystem, the ecosystem acts as a resources provider in this recovery network. All raw materials are taken from the earth. In the same time, the ecosystem is a recipient from the network. Every process generates pollutions more or less [50]. So it is inevitable to say that every stakeholder in the tire scrap network reduces its carbon footprint, be more environmental concern and operate its business in environmentally sustainable way. The following model demonstrates how a sustainable eco-value co-creation tire scrap recovery network should be.

III. RESEARCH METHODS

A. Data collection procedure

This paper combines both primary and secondary data analyses. This involves 15 direct interviews of all tire scrap stakeholders, including 1 tire manufacturer, 4 distributors and dealers, 2 collectors, 1 recycler, and 7 end-users. The semi-structured interviews were carried out from December 2013 to January 2014. For secondary data analysis, this paper provides a thorough study of tire scrap related analysis based on service sustainability concept. However, there are a few studies on the value co-creation in a sustainable service, especially on tire scrap management [1, 4, 10, 19 - 20].

B. Interview policy

Themes and questions used in the interviews were developed on the basis of literature review. The main themes are: (1) current situation of tire scrap management in Thailand, (2) roles or involvement in tire scrap management, (3) perception on sustainable service on tire scrap management, (4) willingness to join the eco-value co-creation tire scrap network, and (5) implications of the tire scrap recovery network. With benefits of semi-structured interview, interviewees were given freedom to bring forth issues they considered relevant from their points of view based on their role in tire scrap management or business. The interview results are analyzed and written in storytelling method to narrative the analysis and make it easy to understand [18].

C. Data analysis

Additionally, in this study, qualitative data were analyzed by using documentation, conceptualization, and examining relationships. Besides observing during the interviews, in the meantime, data were jotted down and conversations were recorded. This leads to the concept of identifying important points integrated for tire management concepts based on the interviewees' ideas. Understanding the concepts are very important and it will be easier by examining their relationship and demonstrate them out in a kind of physical model. Examining relationships allows a transfer of tacit knowledge of interviewees' to a more understandable explicit knowledge. From all the qualitative analysis processes, it can be said that this paper applies a grounded theory to get a

conceptual view of tire scrap recovery network [52]. With all refined links of all important concepts and ideas attained from the interview, a sustainable eco-value co-creation tire scrap recovery model is created. The model is a means to illustrate the implications of the findings of human aspects and in depth literature reviews of this paper.

D. Secondary data analysis Bridgestone on an environmental perspective

According to the outcome of the United Nations Conference on Sustainable Development - Rio + 20, held in Rio de Janeiro, Brazil in June 2012, it is indispensable that the world require sustainable development at all levels. It needs integrated economic, social, and environmental aspects and their interlinkages to achieve sustainable development in all dimensions. The summit also emphasized on the importance of green economy, which is the achievement of a balance between the economy and the environment. Green economy will enhance ability to manage natural resources sustainably with less adverse environmental impacts, less waste, and higher resource efficiency [21].

In 2013, with more than 140,000 employees the largest tire and rubber, the Bridgestone Group, had more than 180 production and development centers in 25 countries and conducted business activities in over 150 countries worldwide. The Group has highly focused on the importance of the environment and has also stated a long term of environmental mission as "to help ensure a healthy environment for current and future generation." While keeping good business performance position, the Group has committed to reduce the environmental impacts of operations and continually worked towards a sustainable society with stakeholders. One of the Group's objectives of long-term environmental vision is going towards 100% sustainable materials. With this objective, the Group committed to enhance natural resource conservation through their operations and product design improvements [22]. The Bridgestone is searching for society where all economic activities in supply chain from resourcing raw materials to product sales are sustainable. In July 2013, the Bridgestone Tier Japan Co., one of tire sales affiliates, established a tire recycle center in Osaka by integrating a retread tire manufacturing factory and a wasted tire disposal factory. The center collects used tire from customers and promotes recycle and reuse of wasted tires, which is Bridgestone's innovation. [53].

Thai Bridgestone was established in Thailand in 1967, with current capacity the company produces more than 10 million tires a year [23]. With the same direction of the Group, of value natural resources, being in harmony with nature and reducing CO_2 emissions [25], Thai Bridgestone has been committed on developing technologies and business practices that encourage raw materials recycle and renewable resources utilization. The Group has expected that the number of automobiles will be doubled in 2050 with strong influences of increasing number of world population and growth of the world economy [24]. Recycling has become more needed for tire production. Therefore, the Group has continually developed innovative processes, products and services to reduce, reuse, or recycle raw materials, water, and energy in their business.

IV. RESULTS

In this paper, to get human aspects on how tire scrap management situation is and how the recovery network should be, direct interviews with all stakeholders were conducted. In this context the tire scrap recovery network focuses mainly on EOL tires. The following part will explain how each stakeholder thinks towards the current tire scrap management and their role on having a tire scrap recovery network.

1) Manufacturers: In Thailand, tire manufacturers play an important role especially producing tires and distributing them to car manufacturers or making tires available in the market by distributing them to dealers or retailers. Owing to the current tire scrap management situation, we have seen that tire manufacturers do not have any physical tire scrap management system. As in the case of the Bridgestone Group, optimizing use of resources is one of their environmental objectives. The Group has been working together with customers and continuously provides products and services based on the environment concerns. In addition, for the terms of tire scrap management, when the company transports new tires to their retail shops, Cockpit, Autoboy, Bridgestone Truck Tire Center, and A.C.T., they collect used tires with no cost at backhaul to reuse, recycle or operate by following the company purposes later. With all key tire manufacturers in Thailand, TATMA has been working on finding ways to recover tire scrap. However, in Thailand there are no laws that mandate responsible party to manage tire scrap. Involved parties run businesses freely in the market. Correspondingly, tire scrap has been collected from different places by different parties. In the context of Bridgestone, the source states that tire scrap recovery network is needed. All involved stakeholders should have distinct roles in this network. Key players in the network should be the government, manufacturers, end users, and recyclers. Above all, decisive laws or at least some rigid strategic plans and preventive measure should be issued to make the network happen.

2) Distributors, wholesalers and dealers: For the role of distributors, wholesalers and dealers, wholesalers and large sized dealers sell new tires to sub-dealers. Sub-dealers sell tires to smaller sub-dealers. This is a usual business activity that normally happens in automobile tire market. However, if the dealers are authorized retailers of a tire manufacturer, they can only sell tire to end-users. For the current tire scrap management situation, wholesalers and dealers do not have any significant activities on tire scrap management. In the past few years, they have offered to purchase used tires from customers with low price. Some dealers offer discounts on

new tires if customers take used tires to the shops. These used tires are sold as second hand tires to sub-dealers, or are reprocessed by regrooving or retreading. With the opinion of sustainable tire scrap recovery network, the interviewed wholesalers and dealers agreed that having a recovery network would make a sustainable tire scrap management. They thought that manufacturers and the government should be major parties in the network. They were willing to be centers of collecting used tires with low or no cost. They also suggested that there should be a project to educate end-users of how to manage with used tires.

3) Collectors: Tire scrap collectors are people who play an important role on current tire scrap since they are either solely collectors or are recyclers who do scrap collection. Moreover, they collect tire scrap from many locations, for example, garages, smaller tire shops, or from used tire buying centers both for free or at low cost. The collected tire scrap is mainly sent to recyclers and cement plants. Some amount of used tires is used in other applications as bumpers, foundation materials, or running mats. For the reason of sustainable tire scrap recovery network, the interviewees agreed that having the recovery network could increase effectiveness of tire scrap management. The current problems were end-users keeping used tires at home without doing anything with them. As the problem related to transportation costs with tire shape and weight, collectors could only bring tires at some level per time.

4) Recyclers: Roles and current tire scrap management situation for tire scrap recyclers show different types of tire scrap recyclers based on technologies and final outputs. Currently, there are tire-grinding companies, pyrolysis companies, and reclaim rubber companies in tire scrap management system. They either buy used tires from collectors or acquire used tires themselves. The outputs of processed used tires will be used as feeding stocks of many industries, such as automobile tire industry, cement industry, petrochemical industry, and steel industry. As predicted, recyclers were willing to join the tire scrap recovery network and agreed that the network would contribute great benefits to the society. They thought that the government should issues some laws that controlled standard level of usable tires, used tire disposing methods, and standards of used tire recycle technologies. In terms of amount of collected used tires, recyclers thought that there would be enough supply in long term.

5) End-users: As for the end-users, there were two groups of end-users: quality conscious and price conscious consumers. They would buy tires that serve their using purposes. Since people concerned and were interested in the environment, some customers have decided to buy environmentally friendly products that give them better performance, more lifespan, and cause less environmental impacts. Currently, tire end-users do not have significant roles in tire scrap management. They sell used tires to dealers or tire collectors. Some of them keep used tires at home with no further use. As for sustainable tire scrap recovery network, end-users thought that current tire scrap management is in very poor stage. There should be some laws that effectively enforce on what and how to do with used tires. Responsible parties should be identified. They suggest that all related stakeholders led by tire manufacturers be involved in the recovery network, which will eventually benefit the environment. In addition, there should be a program to educate people of how to use and manage tires properly.

TABLE1: ANALYZED INFORMATION ON TIRE SCRAP STAKEHOLDERS

	Manufacturers	**Distributors**	**Collectors**	**Recyclers**	**End-users**
Current situation in tire scrap recovery network	– Collect their produced used tires with no cost at backhaul	– No significant activities on tire scrap recovery network	– Collect tire scrap from many locations for further process	– Collect used tires or buy used tires from collectors	– No significant activities on tire scrap recovery network
Motivation to make sustainable tire scrap management	– Provide eco-friendly products and services Optimizing use of resources	– Realize the importance of sustainable management for used tire	– Realize value of used tire Realize the importance of sustainable management	– Realize that sustainable management contributes great benefits to the society	– Require effective tire scrap management for better environment
Issues towards eco-value co-creation	– Have urgent need for an eco-friendly management network – Need decisive laws to make the network happen – Encourage all parties to work for effective and sustainable tire scrap management	– Have manufacturers and government be leaders – Have no tire collection centers for effective transportation – Need programs to educate end-users of how to manage with used tires	– Have no nearby used tire collection centers – Need effective management and policy for used tire collection	– Have no laws to control level of usable tires, disposing methods, and standards of recycle technologies	– Need identified responsible parties and roles – Need all stakeholders to be involve in tire management – Need programs to educate people of how to use and manage tires properly

V. IMPLICATIONS FOR ECO-VALUE CO-CREATION

A. Industry implication

In Thailand, tire scrap management is in the free market system. Players can freely engage and leave the system anytime based on market mechanism. The free market model allows free competition in the market. In the past few years, tire scrap recycle market has attracted many recyclers to jump sharing into huge market stake. As recyclers focus on profit maximization, they sometimes use low technology machines in their business operation. Thus, there should be concerns on business practice and technology standard whether they legally comply. Tire scrap in many countries is successfully managed by implementing the EPR model and tire users or tire collectors pay an amount of tire scrap management fee. This amount fee is used as part of tire scrap management or treatment by tire manufacturers or recyclers. Although public is less involved in the model, the management processes are done freely without government control. These two models seem practical in different perspectives. However, based on human aspects from the interviews, stakeholders agree that tire scrap management in Thailand should take a role in all related stakeholders and manage under some laws or standards in order to ensure that all processes are sustainable and do not affect any environmental, social, or economic impacts to the society. It is indispensable that government, tire manufacturers be the two parties to play major roles in the sustainable tire scrap recovery network.

Tire scrap is considered as materials that are not suitable for remanufacturing. Hence, it is recommended that tire scrap be reused in the production cycle to reduce raw material consumption and lessen environmental impacts [6]. Taken into account, tire scrap logistics and transportation concerns, according to the study of Aylón, bulky shape and toxic composition of tires prevent them to be compressed and flattened. It makes them difficult and expensive to transport and store [43]. From the interviews, tire distributors, dealers, and collectors suggested an idea of having regional or provincial tire scrap buying or collecting centers in order to save transportation costs and time. Additionally, the interviewed tire manufacturer recommended that if there are enough supplies for recyclers to run businesses, it is not difficult to set up a new tire scrap recycling station in any local areas. Adding these two options, there would be regional tire scrap collection centers the collected scrap will be managed properly by local recyclers. Considering outputs, there are currently more demands over supplies, for all kinds of tire scrap recycled products such as fuel oil from tire pyrolysis, reclaim rubber, rubber powder, or even TDF. Dealers and end-users propose that they prefer the government or tire manufacturers to takeoff programs to promote tire scrap recovery network and promote how the network works. In addition to that point, they prefer having those two parties to educate them how to select and use new tires and how to properly manage tire scrap. Apart from all recommendations, every stakeholder agrees that incentive programs launched by the government, manufacturer, dealers, or recyclers will boost up the willingness to be part of tire scrap recovery network of end-users. Using incentives based programs for solving tire scrap management problems in existing markets have become a new paradigm since 1990s [44]. Furthermore, Chang stated in this study that promoting tire scrap management does not only need a comprehensive analysis of interactions of stakeholders in terms of economic impacts and environmental management and valuation, it also needs incentive based tire scrap recycling policy [1].

B. Political implication

Though NGOs do not have any specific roles in tire scrap management in Thailand, they are the important party that contributes to the success of the tire scrap recovery network. Sebhatu stated in his study, external stakeholders, as NGOs have important roles in creating collaborations and relationships among involved parties [45]. In terms of service concept, they can be a mediator among stakeholders both in service providing and service receiving perspectives. Moreover, NGOs are the party that effectively checks effectiveness of recovery network processes especially in recycle technologies and laws or standards obedience. One of the most important factors that highly affect the performance of tire scrap management is effectively enforceable law. As previously mentioned, all stakeholders would like to have practical laws to enforce and control all processes to be done effectively and cause no negative impacts to the society. In Thailand, there are 77 provinces. Each province has a local government division that is able to issue laws that are locally enforceable. The divisions are accountable and cherish these benefits of having self-control power to local residents who eventually bring their faith in democratic regime, the backbone of the country democracy [46]. Even though enacting an act is less likely happened for tire scrap management, with the authority power of the local administrative divisions, it is possible for each province to issue its own laws to regulate on tire scrap management. Under one condition, these laws have to conform to the main act, which in this context is the Enhancement and Conservation of National Environmental Quality Act, enacted in 1992 (NEQA 1992) [47].

With all beneficial points of the free market and EPR models and a strong practical governmental control and tight collaboration of all stakeholders, the tire scrap recovery network is likely to be successful as it will be socially, economically, and environmentally friendly for all sectors in long-term.

VI. CONCLUSION

The economic recovering situation and accelerating demand of automobile concurrently cause higher demand of automobile tires. Within a car lifespan, tires need to be changed for several times. Consequently, used tires are sold

as second hand tires. Becoming on their last stage, they become EOL tires. The EOL tires or tire scrap cause harm to the environment and are very crucial to public health. However, continuous increase in price of oil and other commodities, tire scrap has become valuable materials that can be reused as raw materials for manufacturing process of many industries. The more profit tire scrap gives to its management market, the more players come in. Tire scrap management is a kind of service that has a sustainable management system needed mutual collaboration of all stakeholders. Current obstacles of having such network has no direct laws related to tire scrap management, no identified responsible parties, and no strategic plan for a practical tire scrap recovery network to apply to all areas of the country.

As local administrative divisions have power to issue new laws to enforce locally in their areas, it is a key success factor for the recovery network. Practical enforceable law is a tool ensuring all tire scrap management processes are done properly. This benefit of self-issuing law authority helps creating local tire scrap collection centers. Having this kind of center can solve transportation problems and make the management system run more effectively. Based on the human aspects on having a tire scrap recovery network, all stakeholders agree that the network will contribute benefits to the society and will be one of the most potential ways to sustainably manage tire scrap in Thailand. Not only does this paper show cooperation of all stakeholders for creation of integrated tire scrap recovery network, but also demonstrates an eco-value co-creation model based on a tripartite concept describing how value of co-created in service providers and recipient interaction along a scrap recovery network is.

The fundamental factor that contributes to the success of tire scrap management is to ensure that stakeholders understand their roles and the management processes [51]. The eco-value co-creation of tire scrap recovery network shows how tire scrap management should be by the cooperation of every party from the very beginning of the supply chain, tire manufacturers, to the end of the chain, recyclers, and go back the manufacturers again. This cradle-to-cradle tire scrap management processes offer an essential solution to solve tire scrap management problems in Thailand. Incorporating a human aspect perspective from interviewing with a sustainable service concept, "a tripartite concept", model in this paper shows how a sustainable eco-value co-creation tire scrap recovery network should be. Despite having a tire scrap recovery network applicable for managing tire scrap in the real world, it is important to see if this model is feasible. Applying a tripartite concept to the recovery network, all stakeholders namely service providers, service recipients, and the ecosystem can mutually work together to get the system run effectively, sustainably, and eventually develop co-created values from what they have been involved.

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