Rubber Agro-Industry Green Logistic Conceptual Model

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***Abstract*— Green logistic is a logistics model which takes into account the social and environmental aspects, beside the functional and economical aspects. The objectives of this research are design a structural model of rubber agro-industrial green logistic, SIR 20 (Standard Indonesian Rubber 20) process logistic and design of product packaging of SIR 20 produced by crumb rubber agro-industry. This research is use system approach which was supported by ISM (Interpretive Structural Modelling), Green VSM (Value Stream Mapping) and Fuzzy AHP Green QFD (Quality Function Deployment) techniques. These models are important because the model can facilitate further enhancement efficiency and effectiveness, reduction in environmental impact on each business process stage starting from raw materials, production process and product distribution process as to be able to productivity both on planting means and rubber agro-industry levels. The results of ISM analysis showed that in the objectives of elements green logistic model, which are reduce the environmental impacts of rubber agro-industrial business process, improve the quality of packaging design appropriate to consumer expectations and environmentally friendly, as well as an increase institutional performance in the implementation of objectives achievement of the green logistics system. The results of GVSM analysis showed by improving the quality of raw rubber materials (*bokar*), it can improve the energy usage efficiency by 11%, water usage by 25% and processing time by 2%, therefore the productivity of raw material use increases from 54% to 67%. The analysis results of SIR 20 packaging those consumers want and environmentally friendly factors were ease in packaging products and green packaging materials. Metal packaging material was suggested due to the ease in packaging SIR products and recyclable, while the main weakness was weight and less energy efficient. Based on this attribute a conceptual green logistic model was proposed.**

Keywords: green logistics, *bokar*, rubber, ISM, GVSM, QFD

1. Introduction

Rubber is a very important commodity in Indonesia, because the foreign exchange generated by this commodity is quite large. In MP3EI (Master Plan for the Acceleration and Expansion of Indonesian Economic Development) 2011-2025 [1], it is stated that rubber plantations belong to the main economic activities in Indonesia and focused on Sumatra economic corridor as the main rubber producing areas by 64%.

Moreover, Indonesia as well as Thailand and Malaysia are bound under the International Tripartite Rubber Council (ITRC). Thailand became the largest producer of natural rubber with rubber production in 2015 by 4.473 million tons, while Indonesia ranked the second with rubber production in the same period by 3.1754 million tons, followed by Vietnam with a production of 1.017 million tons. In line with the growth of world industry and economy, demand for rubber as a raw material for the industry will continue to increase. Global natural rubber consumption in 2015 was by 12.314 million tons or growing up by 1.6% [2].

When it is reviewed from the width side, Indonesia has the widest rubber plantation in the world which is 3.62 million ha. However, Indonesian' rubber productivity is still low (1.036 ton/ha/year) [3] compared to Thailand (1.4/ha/year) [4]. Rubber plantation in Indonesia is mostly (85%) owned by the smallholder and the cultural practice is still not optimally managed, so it affects the low national rubber productivity [3].

The power of lands' width and consumption resources which increase is not followed with economic value obtained. Market competition which is getting tight, raw materials supply with inappropriate quality and bad logistic management system also become obstacles in rubber agroindustry management process like crumb rubber industry. Crumb rubber industry in Indonesia only operates with utilization below 70% from installed capacity due to the shortage of raw rubber material [5]. Smallholder's rubber productivity increase needs to be conducted proportionally to meet crumb rubber industry necessity adjusted to market absorption.

In order that rubber commodity can compete in both domestic and international market, it efficiency and effectiveness are needed in rubber logistic management in Indonesia. Rubber industry supply chain starting from producer (smallholder) up to the final user (customer) through various process stages involve supply chain conductor from smallholder, brokers, traders, suppliers, retailers, and customers as the final chain. Raw rubber material marketing pattern from smallholder to industry/exporter is generally still using traditional institution with long enough chanels [6] which cause low efficiency and effectiveness on rubber agroindustry. Some other studies in rubber agroindustry field have been conducted [7], [8], [9], [10], [11]. However they did not study green logistic aspect in rubber agroindustry management process.

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Logistic is a part of Supply Chain [12]. Green logistic is defined as an effort to examine and minimalize environmental effect from logistic activities involving transportation, storing, packaging, materials movement, management and distribution [13], [14]. In this case, there is a tendency in customers who willingly pay more for products from companies that care about environment. Therefore, deeper study to make green logistic is more interesting from business and social perspective in an agroindustry is needed, like rubber agroindustry.

The objectives of this research were to design a structural model of rubber agro-industrial green logistic, SIR 20 (Standard Indonesian Rubber 20) process logistic and design of product packaging of SIR 20 produced by crumb rubber agroindustry. The scopes of this study are:

- Rubber agroindustry which acts as study sample is crumb rubber agroindustry in Palembang, South Sumatera, Indonesia,
- Structural elements analysis of the purpose of rubber agroindustry green logistic model designing by using ISM,
- Dissipation analysis in logistic system of rubber agroindustry process by using GVSM,
- Factor analysis affecting on economic and environmental friendly packaging design by using Fuzzy AHP GQFD.

2. Literature Review

2.1 Green Logistic

Logistics can be defined as a tool for moving raw materials, goods and people to the right place at the desired time. Consequently, logistic is an important function and element of modern transport systems, not only at a national level, but also in a wider global context. It is obvious that the expansion of logistics was supported by globalization, decentralization of production and development of supply chain concepts [15].

While green logistic is management activity to pursue customer satisfaction and for social development purpose, it connects the main supply and demand section, solve space and time obstacles to achieve efficiency and fast movement of goods and services. This is required to hamper environment damage in achieving logistic environment purification and the best use of logistic power. Green logistic is multi-level concept involving green logistic business activity and social activity for green logistic, standardization and control management [16].

2.2 Interpretive Structural Modeling (ISM)

The Interpretive Structural Modelling (ISM) process transforms unclear, poorly articulated mental models of systems in to visible, well defined models useful for many purposes [17]. ISM analyzes system elements and breaks it in the form of graphic from direct connection among elements and hierarchy level. ISM is a method which can be implemented on a system to understand direct and indirect connection among components in the system better [18].

ISM is a sophisticated interactive planning methodology which allows a group of people, work as a team, to develop a structure defining connection among elements in a community. The structure is obtained by answering simple questions. Structured elements (such as purpose, obstacles, problems, and so on) are decided by a group in the first ISM planning session [19], [20], [21].

2.3 Value Stream Mapping

Value Stream Mapping is a tool which can be used to map value stream in detail to define the dissipation and find the causes of dissipation as well as give the right method to eliminate or reduce them [20].

Next, VSM method is developed which regards environmental aspect, which is Green VSM [22]. Green VSM methodology regards all activities in value stream or business operation and decides either from environmental (with customers in the context of VSM lean), each activity, process or operation which is positive, good or valuable perspectives. Otherwise, it is considered as dissipation, so it needs to be changed or eliminated. The purpose is to move organization into continuity by focusing on "green waste" reduce which affect environment [23].

2.4 Fuzzy System

Fuzzy system assumes a function by fuzzy logic developed by Lotfi A. Zadeh in 1964. Fuzzy system is structured and dynamic numeral presumption. This system has ability to develop intelligent system in an uncertain and inappropriate environment [24], [25], [26]. Fuzzy logic is being applied in a wide range of applications in engineering areas ranging from robotics and control to architecture and environmental engineering [27].

2.5 Analytical Hierarchy Process (AHP)

The AHP, introduced by Thomas L. S., addresses how to determine the relative importance of a set of activities in a multi-criteria decision problem [28]. AHP work principle is simplifying an unstructured, strategic and dynamic complex problem into sections and arranged in a hierarchy [29]. Graphically, AHP decision matter can be constructed as multilevel diagram, starting from goal, then first level criterion, sub criterion and eventually alternatives [30].

2.6 Quality Function Deployment (QFD)

QFD is a system to translate and plan customer voice become product, process, and service product quality characteristics to achieve customer satisfaction [31]. QFD is a tool to design and develop new product which is able to integrate quality into design, meet customer needs and wants which is translated into technical responses. In product design and development process, QFD is used in product concepts evaluation stage [32].

Next, developed Green QFD which is used to evaluate product concepts with stages as follows [33]:

- Identifying technical response. The purpose of this phase is to identify quality and environment of technical response through analysis which is based on product, demands on this technical response is used to develop new packaging concept.
- Generating product concept. The purpose of this phase is to develop a row of product packaging concept alternatives to meet demands which have been

determined in phase I. The concepts and product concepts fundamental line are evaluated to select product packaging design concept through Concept Comparison House (CCH).

3. Methodology

This research activity is conducted in three stages which are structural model design for green logistic, rubber processing materials process logistic model and SIR 20 product packaging design. Further research stages are shown on Figure 1.

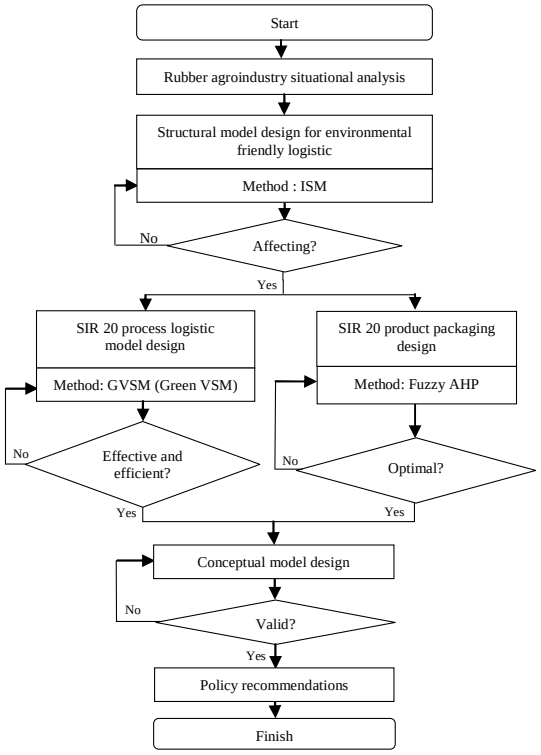


Figure 1. Research framework of rubber agroindustry green logistic

3.1 Crumb Rubber Agroindustry Situational Analysis

Crumb rubber agroindustry is a rubber industry that process raw materials of rubber mainly come from rubber smallholder into form of slabs, lump, cup lump and sheet to be a technically spesified rubber (TSR) known in Indonesia as Standard Indonesian Rubber (SIR). Today the amount of raw materials of rubber produced by smallholders reaches 2.4 million tons per year. Crumb rubber industry can be absorbed by reached 5.0 million tons install capacity of dry rubber per year. With the available lands and infrastructure condition, most of smallholder's rubber is marketed in the form of coagulum known as slab which is used as raw materials of crumb rubber industry [5].

The processing involves a series of crumb rubber industrial process starting from supplier of raw materials of rubber until customer SIR 20 like what is described in SIPOC Diagram (Supplier–Input–Process–Output-Customer) in Figure 2.

3.2 Structural Model Design of Rubber Agroindustry Green logistic Using ISM Method

The ISM is interpretive as the judgment of the selected group for the study decides whether and how the factors are interrelated. This section deals with discussion of ISM methodology and cross-impact matrix multiplication applied to classification is abbreviated as MICMAC [34]. The various steps involved in the ISM methodology [35] are as follows:

1. Variables affecting the system are listed; in our research work factors to implement green logistic system in rubber agroindustry have been identified as variables.
2. From the variable identified in step 1, contextual relationship among variables is examined.
3. A Structural Self-Interaction Matrix (SSIM) is developed for variables, which indicates pair wise relationship among variables of the system under consideration.
4. A reachability matrix is developed from the SSIM and the matrix is checked for transitivity. The transitivity of the contextual relationships is a basic assumption made in ISM. It states that if a variable A is related to variable B and variable B is related to the variable C, then variable A necessarily is related to variable C.
5. The reachability matrix obtained in step4 is partitioned into different levels.
6. Based on the contextual relationships in the reachability matrix, a directed graph is drawn and the transitivity links are removed.
7. The resultant digraph is converted into an ISM by replacing variable nodes with statement.

3.3 Logistic Model Design of SIR 20 Production Process Using GVSM Method

In GVSM concept, there are seven green waste generation sources consisting of energy, water, material, waste, transportation, emission, and biodiversity usage. This is also the same with VSM concept; GVSM also has two kinds of mapping, which is current state and future state. There are two steps of using this GVSM method, which are:

- Develop Current State GVSM. Current State Green Value Stream Mapping describes initial condition before productivity increasing effort is conducted. Process initial condition mapping is conducted by identifying seven waste sources based on Wills [23]. Seven waste sources identification or known as seven green wastes is conducted in process stage.
- Develop Future State GVSM. After creating GVSM, actual condition and focus on big and what bring huge impact, brainstorm with experts and key person responsible on the process starting from design product until the product arrives on customer. In addition, monitoring is also conducted by seeing process directly and make correction and facts on the field regarding energy, water, material, waste, transportation and emission use, then Future State GVSM is established which can produce rubber agroindustry business process effectively and efficiently in term of energy, water, materials use, and others.

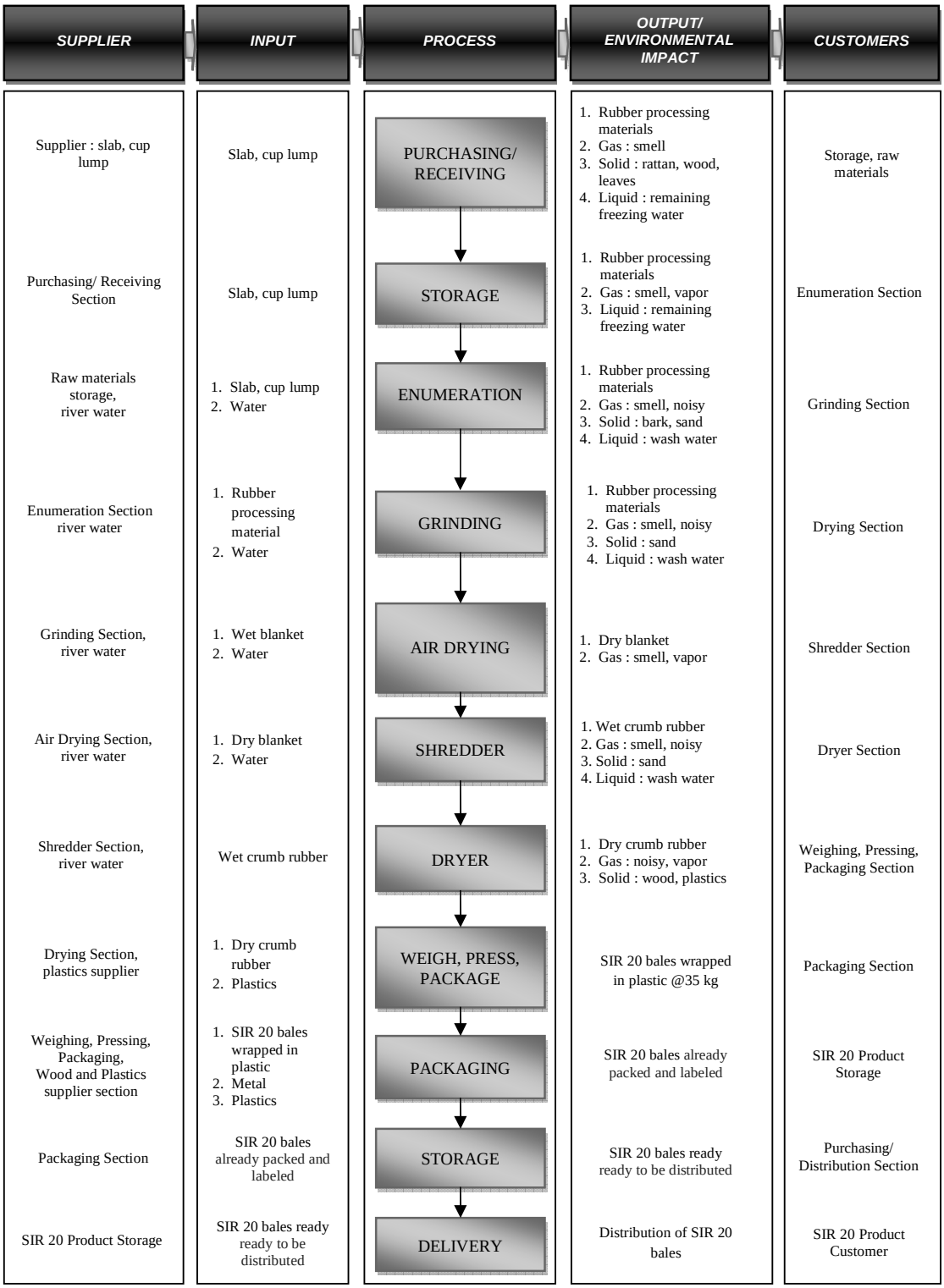


Figure 2. SIPOC diagram of SIR 20 production process

3.4 SIR 20 Product Packaging Design Using Fuzzy AHP

One method to investigate customer's wants in product design is QFD (Quality Function Deployment). QFD implementation consists of three steps, in which all activities conducted on each steps can be implemented like a project, by firstly conducting planning and preparation steps, the three steps are [36]:

- Collect of Customer's Voice :
  (1). Customer requirement identification is conducted by selecting packaging attributes by considering the level of interest given to respondents. The decision of customer priority level using Fuzzy AHP method based on respondent assessment result,
  (2). Creating technical characteristics derived based on packaging attribute required by customer,
  (3). Creating relationship matrix among SIR 20 product packaging attributes with technical characteristic using Fuzzy AHP method based on respondents assessment result,
  (4). Creating relationship matrix among technical characteristics used to assist QFD team in determining design experience bottleneck and finding communication key among SIR 20 product packaging designers.
- House of Quality Arranging.
- Analysis and Implementation.

4. Discussion

4.1 Structural Analysis for Green Logistic Model Designing of Rubber Agroindustry

Data in structural model implementation for green logistic model designing of rubber agroindustry was collected based on opinions of several related parties with logistic system of rubber agroindustry in South Sumatera are: Rubber Association of Indonesia, Sembawa Research Center – Indonesian Rubber Research Institute, VCU (Village Cooperative Unit) Berkat in Prabumulih, Rubber smallholders in Prabumulih, rubber agroindustry companies, Environmental Agency and Research Center and Palembang Industrial Standardization Office.

Elements structuring for environmental friendly model designing on Figure 3 indicates that rubber-based agroindustry growth and supporting industry of rubber agroindustry logistic system activities sub elements are at level 1. The achievement of this sub element depends on other objective achievement success in green logistic model of rubber agroindustry.

Based on Figure 3, it is seen that sub elements: reducing environmental impact of rubber agroindustry business process, increasing packaging design quality as expected by customer and environmental friendly and the increasing of green logistic system performance are sub elements which are on fundamental level which can affect changes on other sub elements. Impact which occurs on three sub elements can affect other sub elements, so at the final level, environmental friendly rubber agroindustry logistic system will affect rubber-based agroindustry growth and supporting industry of rubber agroindustry logistic system activity.

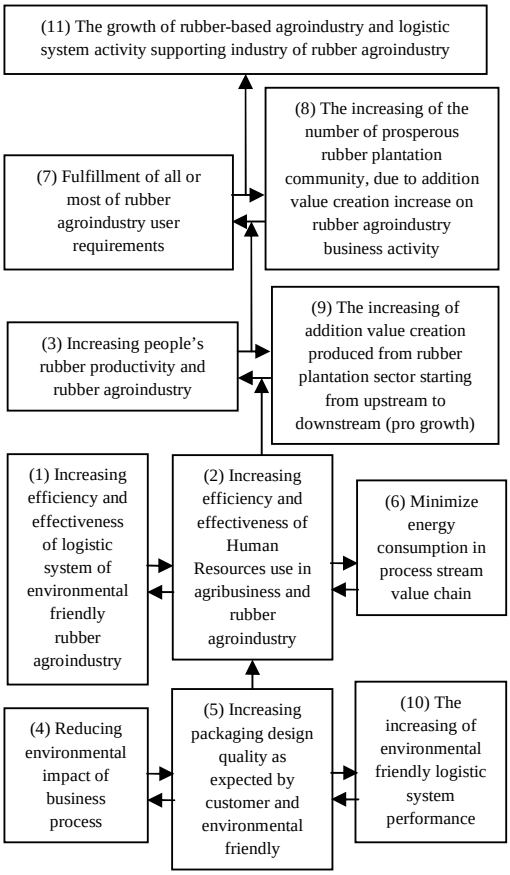


Figure 3. Structuring elements green logistic objective

Analysis result of ISM indicates that sub elements of: reducing environmental impact of rubber agroindustry business process, increasing packaging design quality as expected by customer and is environmental friendly and the increasing of green logistic performance are key elements. The three sub elements lay on sector IV (Independent) as shown on Figure 4.

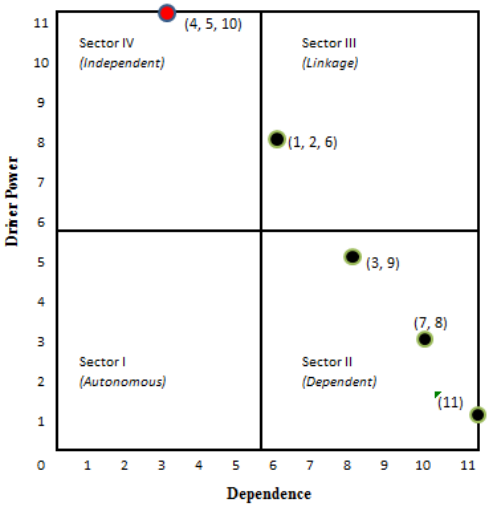


Figure 4. Driver Power – Dependence matrix of objective elements

Sub element on this sector has moving power for the success of development program of green logistic system of rubber agroindustry in South Sumatera, although it has a little dependence on the program.

4.2 Logistic Analysis on SIR 20 Production Process

Crumb rubber agroindustry process rubber processing materials to produce products which follow Indonesia National Standard (INS) of SIR so it can be exported and sold in domestic market. If rubber processing materials processed is dirty, then long and wasteful process stages are required as to create low productivity. Therefore, waste generator source analysis is conducted in the process of crumb rubber processing like what is presented on Table 1.

4.3 House of Quality Design of SIR Product Packaging

Quality Function Development (QFD) is a method for translating customer requirements into appropriate company requirements at each stage, from research and product development, to engineering and manufacturing, to marketing/sales and distribution [38]. Based on customer wants on SIR product packaging, then relationship analysis of customer wants on technical characteristic of the packaging processing process is required. This is conducted so SIR product packaging can

Table 1. Results of green waste sources analysis

Type of Wastes	Process Stages								Total
	Raw Materials Receiving	Enumeration	Grinding	Air Drying	Shredder	Dryer	Weighing, Pressing, Packaging	Packaging and Storing	
Processing Time (hour)	1	4	5	120	6	6	6	12	160
Energy									
a. Electricity (kWh/day)		10,072	6,491		2,686	739	403		20,391
b. Natural gas (MMBtu/day)						140			140
c. Gasoline (liter/day)						240			240
d. Oil (liter/day)		3.1	1.99		0.8	0.23	0.12		6.24
e. Lubricants (kg/day)		1.68	1.08		0.45	0.12	0.07		3.4
Water									
a. River (m^3/day)		1,561	1,214		1,095	411			4,280
b. Materials (m^3/day)		16	8						24
c. Reuse Water (m^3/day)		861							861
d. Recycle Water (m^3/day)		1,095							1,095
Materials									
a. Raw Materials (ton/day)	200	200	200	107	107	107	107	107	
b. Polyethylene plastics (ton/day)							40		40
c. Pallet Wood (unit/day)								53	53
d. Metal Box (unit/day)								27	27
e. Waste Reagent Lab. (ml/day)							1.6		1.6
f. Turpentine (liter/day)							80		80
g. Curio TS (liter/day)							0.32		0.32
h. Natrium Hydroxide (kg/day)							3.2		3.2
Emission (Average)									
a. CO (ppm)			0.769			1.866			1.3175
b. H_2S (ppm)			0.016			0.010			0.0130
c. SO_2 (ppm)			0.019			0.021			0.0200
d. NO_2 (ppm)			0.019			0.023			0.0210
e. NH_3 (ppm)			0.286			0.156			0.2210
f. Dust (mg/m^3)			0.163			1.833			0.9980
g. Noisy Level (dBA)		81	86		90	77			84.33

Next, in this study Future State Green VSM is design by increasing rubber processing materials quality on smallholder level which is required to use clean raw rubber materials and free from wood cuts and other solid wastes. If the raw rubber materials are clean then electrical power use efficiency on processing process reduces by 11% (from 20,391 kWh into 18,190 kWh), water use reduces by 25% (from 4,280 m^3/day into 3,210 m^3 /day or 21,4 m^3 water/ton of dry rubber into 16,05 m^3 water/ ton of dry rubber) and processing time by 2% (from 160 hours into 156.7 hours) and raw materials use productivity increase from 54% (107 ton of SIR 20 product of 200 ton of raw rubber materials) into 67% (134 ton of SIR 20 product of 200 ton of raw processing materials) like is shown on Figure 5. The reduce of this energy consumption is in accordance with the main principles of green logistic on manufacturing step which it can reduce energy consumption, use a technology supporting clean production and reduce waste production [37].

meet customer wants like is shown in quality house presented on Figure 6.

In WHAT matrix, survey to obtain customer voice is conducted which indeed requires time and skills to listen. QFD process needs written customer data as attributes of SIR product packaging. Each attribute has numeral data relate to attributes relative interest for customer and customer satisfaction performance level of SIR product packaging which is made based on the attribute. From WHAT's sub matrix collected, it is known that rubber processing materials wanted by customers are from easiness factor in packaging SIR product and environmental friendly packaging materials.

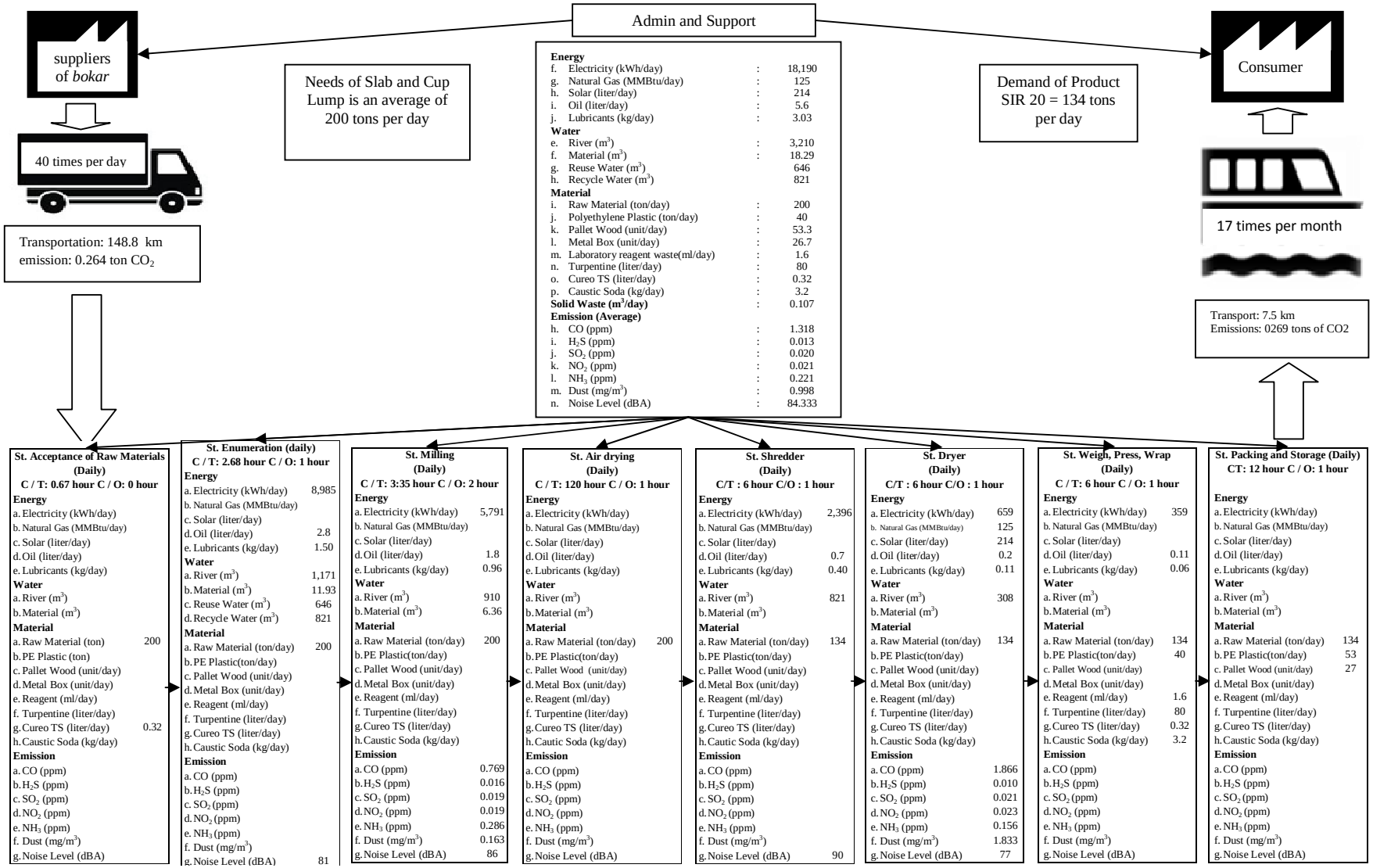
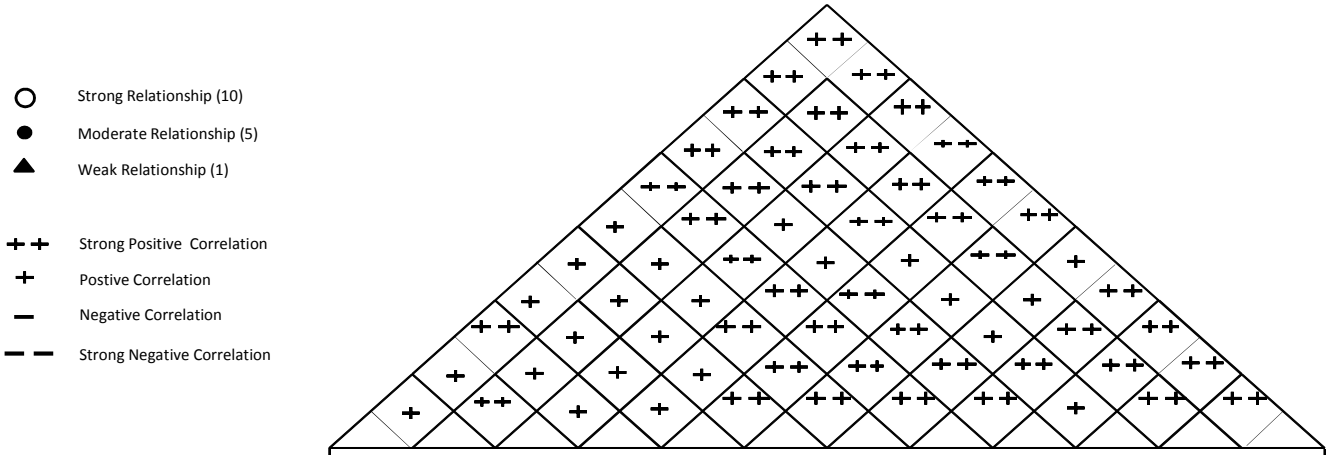


Figure 5. Future state GVSM of crumb rubber agroindustry producing SIR 20



Customers Requirement	Symbol	Priority Level of Consumer	Material		Manufacture		Assembly		Transport.	Use		Disposal					
			Quality of raw materials	Not using hazardous materials	Waste control	Use of energy saving	Availability of equipment manual	Use of tools	Ease of carriage	Energy consumption	Maintenance	*Reduce*	*Reuse*	*Recycle*	Metal	Wood	Plastic
Ease in packaging products	CR_1	8	○	○	▲	○	○	○	○	○	○	●	○	○	7.00	2.00	2.00
Green packaging materials	CR_2	7	○	○	○	○	●	●	●	●	●	○	○	○	3.00	4.00	4.00
Can be used repeatedly	CR_3	4	○	○	○	○	○	●	●	●	●	●	○	○	4.00	6.00	2.00
Can be recycled	CR_4	3	○	○	○	○	○	●	●	○	○	●	○	○	7.00	3.00	1.00
Energy saving	CR_5	3	○	●	○	○	○	●	●	○	○	●	○	○	1.00	6.00	4.00
Ease of assembly	CR_6	6	○	○	●	○	○	○	○	○	○	○	○	○	2.00	4.00	6.00
Ease of repair	CR_7	1	○	○	●	●	○	○	○	○	○	●	●	●	6.00	4.00	1.00
Dimension	CR_8	1	●	▲	▲	●	●	▲	○	○	○	●	●	●	6.00	4.00	2.00
Weight	CR_9	1	●	▲	▲	▲	●	●	○	○	○	●	●	●	1.00	3.00	1.00
Quality of packaging	CR_{10}	5	○	○	○	○	○	○	○	○	○	○	○	○	5.00	4.00	2.00
Price	CR_{11}	2	○	○	○	○	○	○	○	○	○	○	○	○	2.00	2.00	8.00
Current condition			7	6	1	4	5	1	1	4	1	3	2	2			
Value (level of importance)			400	377	285	391	365	311	325	355	355	305	395	395			
Relative value			0.094	0.089	0.067	0.092	0.086	0.073	0.076	0.083	0.083	0.072	0.093	0.093			

Figure 6. House of quality of SIR 20 product packaging

Currently metallic SIR product packaging has advantages, which are easiness in packing SIR product and metallic product packaging can be recycled, while the main disadvantage is it consumes much energy and heavy.

Meanwhile on HOW's matrix, current condition of technical characteristic in the event of producing SIR 20 product packaging as expected by customer wants is determined. Based on result of survey and study literature, technical characteristic owned in this SIR product packaging Life Cycle Phases is raw materials (raw materials quality and do not use dangerous substances), manufacture (waste control and economic energy use), assembly (assembly module availability and supporting materials use), transportation (transportation easiness), use (energy consumption and maintenance) and disposal (reduce, reuse and recycle).

Next, based on technical characteristic calculation which has high interest level is raw materials quality, reuse and recycle. Technical characteristic conditions which can be satisfied now is in terms of raw material quality and do not use dangerous substances, while lacking in waste control, supporting tool use, transporting easiness and maintenance. Therefore, metallic packaging design can be considered as green packaging. The green packaging goes through the entire logistics process and requires companies to prevent the environment from being polluted by the packaging in manufacturing process, logistics, marketing activities, and consumption area [39].

One effort to reduce the high cost of logistics is to implement a logistic green (environmentally friendly logistics). Green logistics is all an effort to minimize the environmental impact of logistics activities from beginning to end including reverse logistics process. In the countries of South eastern Europe designed environmentally friendly logistics with efficient transport and shifting shifts, optimizing network use: the transport unit and environmentally friendly packaging materials, facilities and environment-friendly operation and the process of recycling [15]. In Lithuania already done a study on the impact of globalization on green logistics centre [37]. Comparison on design attributes according to customer wants and environmental friendly, result of the study compared with previous studies shown in Table 2.

4.4 Rubber Agroindustry Green Logistic Conceptual Model

In this study designed logistics conceptual model of green logistic agro-industrial rubber based on the evaluation and assessment of the development of the resulting model as shown in Figure 7. The results of the analysis of the key elements that generate output related to design sub other models in this study. Figure 7 showing that there are two variables element analysis results on the key elements of logistics green logistic agro-industrial rubber.

The results of ISM analysis showed that the continuity of *bokar* supply constraints was highly dependent on the successful handling for other constraints in the green logistics in rubber agro-industry. The results of ISM analysis showed that in the objectives elements of green logistic model was key elements, which were reduce the environmental impacts of rubber agro-industrial business process, improve the quality of packaging design appropriate to consumer expectations and environmentally friendly, as well as increase institutional performance in the implementation of objectives achievement of the green logistics system.

Table 2. Comparison with previous studies on the design attributes of environmentally friendly packaging according to customer needs

Study Result	Previous Studies				
	Ref.[38]	Ref. [39]	Ref. [40]	Ref. [42]	Ref. [43]
SIR 20 Product Packaging	SMEs Industries	Air Conditioners	Air Conditioners	Crumb Rubber Products	Computer design and manufacture
Easiness in packaging product	Efficient communication	Cools quickly	Energy consumption	Too thick chunks of rubber complicate cutting process	Speed
Environmental friendly packaging materials	High employee benefits	Quiet	Toxicity of Material	The number of materials affect production	Energy Saving
Easiness in assembly	Consumer Safety	Less energy consumption		Enough water supply can assist dirt division process	No Toxic Material Released
Packaging Quality	Compliance in product	High durability		Water content inside rubber affects the lengths of drying process	Size or Weight
	Least cost on product	High performance		Pallet supply affects storing and product transporting process to finished product storage	Price or Cost
		Easy to repair		Dirt/ washing division process can reduce dirt content contains in raw materials	
		Harmless to living environment		The availability of supporting tool like *gancu* and machetes make cutting process easy	

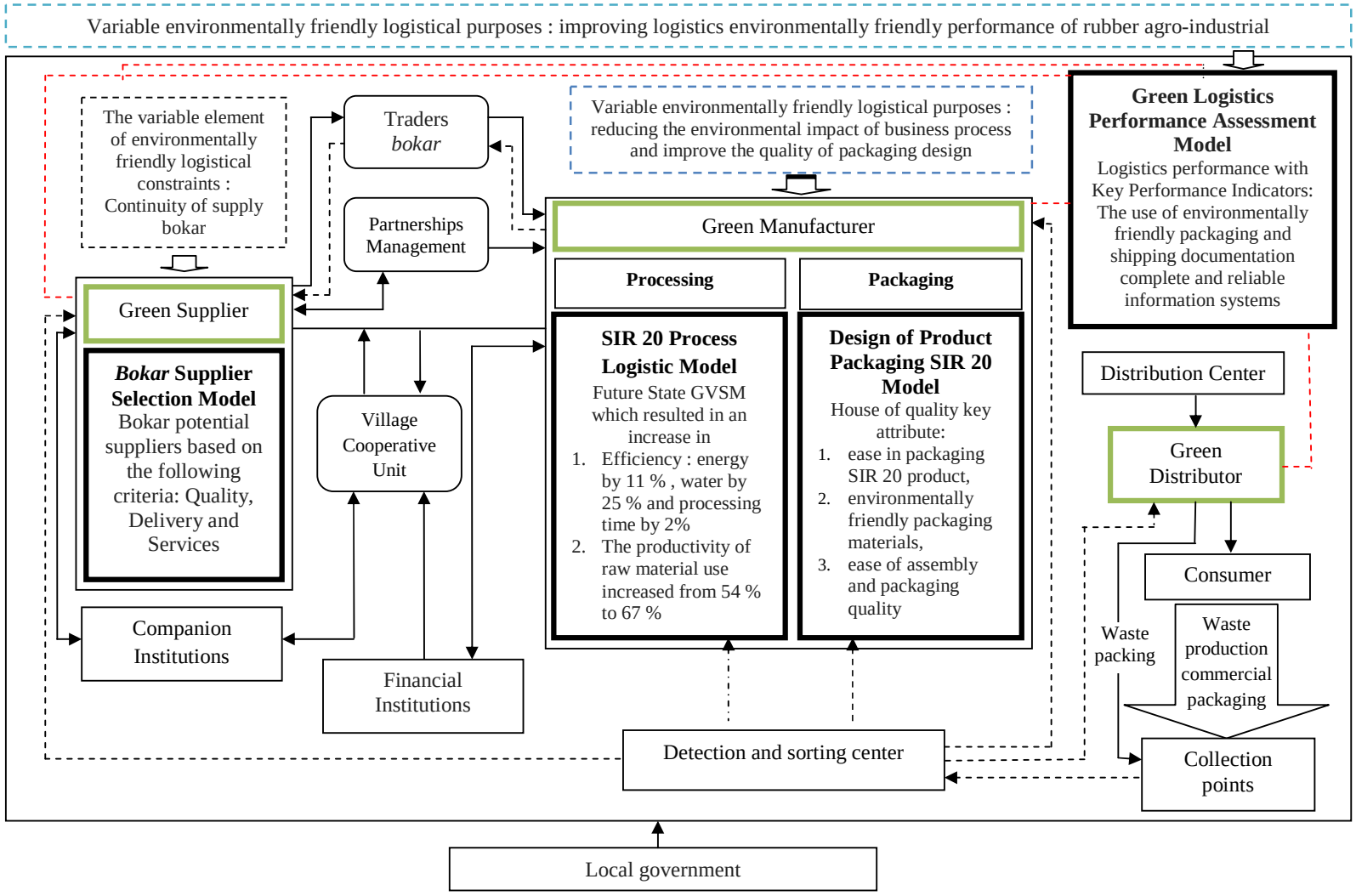


Figure 7. Conceptual model of Rubber agro-industry green logistic

5. Conclussions

5.1 Conclusions

The key elements of green logistic model design objective were reducing environmental impact of rubber agroindustry business process, increasing packaging design quality according to customer's expectation and environmental friendly as well as the increase in green logistic system performance. Of structuring result, it can be said that rubber-based agroindustry growth element and supporting industry of rubber agroindustry logistic system activity was on level 1.

Increasing rubber processing materials quality increased the efficiency of energy usage by 11%, water usage by 25% and processing time by 2% so raw materials use productivity increased from 54% into 67%.

SIR-20 packaging attributs suggested were easiness in packaging SIR product, environmental friendly packaging materials, easiness in packaging assembly and quality. The technical characteristics that must be considered in rubber packaging design were raw materials quality, reuse and recycle. The packaging material suggested was metal; however it faced low energy inefficiency.

5.2 Managerial Implication

The success of green logistic system implementation of rubber agroindustry will have sizeable managerial implications, such as:

- Increasing efficiency and effectiveness that so productivity both on planting means and post harvesting levels.
- The reduce in environmental impact on each business process stage starting from raw materials, production process and product distribution process as to be able to enhance environmental friendly rubber agroindustry development.
- Minimize energy consumption in process stream value chain.
- The increase in SIR 20 product packaging design quality according to customer expectation and is environmental friendly.
- Rubber processing materials quality standard and rubber processed product increase. The creation of sinergy among involved parties both direct and indirectly in rubber agroindustry logistic management starting from rubber farmers, rubber agroindustry entrepreneurs, government up to surrounding society.
- Expansion of activity value of chain and chain of value which is able to give added value increase.
- Increasing rubber processing materials quality, processing process and product packaging design produced by rubber agroindustry as expected by customers and is environmental friendly.
- The increase in institutional performance in target achieving implementation of environmental logistic system.

Conducive business climate and customer satisfaction increase will be created so eventually it can enhance growth and development of rubber central area as industrial raw material supply and increase infestation activity by society, especially in rubber plantation sector and rubber processing industry.

5.3 Suggestions

This study suggested that:

- The development of rubber commodity competitiveness needs to be continuously improved and focused on several quality standard requirements such as rubber processing materials standardization, processing process, packaging design and environmental impact of each logistic step of business process of rubber agroindustry.
- Synergy of all involved parties to create conducive business condition in green logistic system, especially in: (1) Developing rubber central area as rubber agroindustry raw material supplier and (2) Increasing investment in rubber plantation and rubber processing materials processing industry sectors which produce excellent and environmental friendly rubber-based products.

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