Critical issue mapping of Indonesian natural rubber industry based on innovation system perspectives

D Kurnia¹, Marimin², U Haris³ and Sudradjat⁴

¹PhD Candidate at School of Business, IPB University, Jln Pajajaran, Bogor 16151 Indonesia
²Faculty of Agricultural Technology, IPB University, Jln Raya Darmaga, Bogor 16680 Indonesia
³Rubber Association of Indonesia, Jln Cideng Barat 62-A, Jakarta 10150, Indonesia
⁴Faculty of Agriculture, IPB University, Jln Raya Darmaga, Bogor 16680, Indonesia

Email: dadangkurnia96@ymail.com

Abstract. The added value of Indonesian natural rubber industry is the lowest among other main natural producing countries, Malaysia and Thailand. It is necessary to overcome this problem especially based on innovation system perspectives. The objectives of this study are to map the problems of the natural rubber industry and developing alternative solutions to these problems. This study use systems approach, namely Soft System Methodology (SSM) and Strategic Assumption Surfacing and Testing (SAST), which aim is to get a complete picture (rich picture) of the problems in Indonesian rubber industry and to identify the strategic issues that become the industry priorities through sectoral innovation system approach. Based on the mapping of strategic issues, it shows that almost all indicators were in a certain planning region. Such as policy issues (general/parent policies, financing policies, price policies, tax policies for R&D and Innovation, education and training policies), Institutional Issues (formation of financial institutions and institutional arrangements), Human Resources, Industrial issues (Development of downstream industries), technology (technology development as needed), as well as financial and market problems. This implied that there were many strategic and urgent problems that must be addressed in the development of the downstream industry and the innovation system of Indonesia's natural rubber industry. It is important to highlight the interaction between innovators, intermediaries and innovation users. In addition to the interaction within the system, interactions outside the systems are also needed, such as foreign research institutions, etc. Government and financial institution support, strengthening the innovation institution and the existence of a legal direction and protection (such as the system innovation law/act) are the key factors in enhancing the innovation-based industry and increasing the industry competitiveness.

Keywords – Innovation System, Indonesian Natural Rubber Industry, SAST, SSM

1. Introduction
The market domination of a commodity by a country greatly determines the commodity market structure in international trade. In other words, the market share of a commodity shows the influence of the country on total world trade [1]. There are four producing countries, which control the world rubber
trade, namely Thailand, Indonesia, Malaysia, and Vietnam. In 2016 these four countries had a market share of 27.95% for Indonesia, 6.95% for Malaysia, 39.03% for Thailand and 7.21% for Vietnam.

The average productivity of Indonesia is far behind compared to Thailand and Malaysia, which is only 1000 kg of dry rubber/ha/yr [2-4], while productivity in Thailand reaches 1700 kg of dry rubber/ha/yr [5], Malaysia amounted to 1600 kg dry rubber/ha/yr. and Vietnam at 1720 kg/ha/yr [4]. The IRSG (International Rubber Study Group) data shows that during the period of 2011-2015, the average of Indonesia's natural rubber production was 3.1 million tons, while domestic consumption reached 497 thousand tons [6]. This shows that the Indonesian rubber industry relies on primary products, which is producing raw rubber. On the other hand, the absorption of domestic manufacturing industries that convert raw rubber to finished rubber goods is only about 16%. While Malaysia's manufacturing industry able to absorb 52% of its total natural rubber production [7]. Such conditions in Indonesia, have resulted in a non-optimal acquisition of foreign exchange, value-added and labor absorption [8].

Although Indonesia's natural rubber production during 2011-2016 was relatively stable, the export value declined considerably. This is influenced by the price of natural rubber in the international market, which tends to continue to decline. The price of SIR 20 (Standard Indonesian Rubber) in 2011 reached 4.6 USD per kg, continuing to decline to an average of 1.39 USD per kg in 2016 [6].

The added value of Indonesian rubber products is among the lowest compared to Malaysia and Thailand. The export value ranges from 2.1-3.9 USD per kilogram, far below Malaysia which reaches 11.5-12.7 USD. This shows that the rubber-based manufacturing industry in Indonesia is still far behind compared to Malaysia. In 2013 the value of Indonesian exports fell compared to 2011 by 41%, while Malaysia only decreased by 15% and Thailand fell by 18%. Even for Malaysia, the value per kilogram has not decreased. Meanwhile, the contribution of exports to the Gross Domestic Product (GDP) of Thailand is very real, with a contribution of ± 60%, where the natural rubber industry is included in the top ten. Since 1991, Thailand is the number one producer of natural rubber in the world and this industry absorbs more than 6 (six), million workers. Thailand's natural rubber production in 2015 reached 4,324 million tons [4], with a total area of 3,118 million ha [9], and rubber has always been one of Thailand's top ten export products and is currently the country largest agricultural export.

Compare to Indonesia and Thailand, Malaysia applies a different strategy in developing its natural rubber industries. Malaysia is more focused on developing the downstream industry, so it is not surprising that the area and production of Malaysian natural rubber continue to decline. Malaysia's natural rubber production in 2007 reached 1.2 million tons, but in 2015 it only reached 668 thousand tons [4]. Thailand is very competent in advancing rubber plantations, they even able to integrate it with the world rubber economy. Their natural rubber agribusiness system has been very integrated with the economic system in the country. Relations between subsystems, ranging from the provision of production facilities, rubber farming by smallholders and large companies, rubber processing and marketing by cooperatives and the rubber exports to imports in the United States, China, and Japan have been very good [10]. Along with the supporting subsystems in the form of administrative service support systems, funding, counseling/training and research and development [11].

Although Indonesia's natural rubber industry faces various challenges and problems, it does not mean that there is no opportunity for its development. Opportunities to increase added value exist in the latex-based industry such as gloves, rubber threads, pacifiers and condoms whose demand continues to increase.

2. Research objective
From the background above, the purpose of this study is to map the problems of the Indonesia latex-based natural rubber industry (especially rubber gloves industry), identifying the critical issue and looking for alternative solutions to these problems.
3. Methodology

The analytical tool used in this study is expert depth interviews, descriptive analysis to describe the development of downstream latex-based natural rubber industry. Furthermore, this study uses (Soft System Methodology (SSM) [13], and SAST (Strategic Assumption Surfacing and Testing) [14-15].

In-depth interviews and questionnaires involved several experts selected by purposive sampling. Experts are selected from various stakeholders such as government, industry, R & D institutions, financial institutions and industry associations. A detailed description of respondents can be seen in table 1.

Table 1. Respondents of research.

| Profession            | Number of experts | In-depth interviews | SAST Questionnaire |
|-----------------------|-------------------|---------------------|--------------------|
| Government officials  | 6                 | 2                   |                    |
| Company (industry)    | 5                 | 1                   |                    |
| Association members   | 4                 | 1                   |                    |
| R and D institutions  | 4                 | 1                   |                    |
| Financial institutions| 1                 | 1                   |                    |
| Total                 | 20                | 6                   |                    |

Soft System Methodology (SSM) is a descriptive approach (qualitative) aimed at explaining a situation or reality through a logical system, especially describing human aspects, which in this case are the cognitive thinking that is generated through logical systems such as strategy (vision, mission, culture, strategic goals, roles, norms, and values) and the analysis of other aspects such as other dominant external conditions (political). SSM combines these aspects to produce a synergy between the two. The results of the normative process by SSM will be used as material to criticize reality resulting from 7 (seven) processes/cycle stages shown in figure 2 [13]. In this study, stage 1 and 2 are discussed.

SAST is a soft system method (SSM) used to solve problems that are interrelated and complicated, with unclear objectives, conflicts of interest, as well as environmental uncertainties and social constraints. The procedure of SAST is: (1) group formation, which is the formation of groups related to the stakeholders involved in the policy process; (2) assumption surfacing, i.e. raising assumptions from experts; (3) Dialectical debate & rating, a discussion by means of dialectic debate and making rating; (4) Final synthesis, which is the process of synthesis to achieve compromise on assumptions to produce a new strategy. There are four groups of assumptions or quadrants in the SAST, the Quadrant I "Certain and importance"; Quadrant II "Importance and uncertain"; Quadrant III "Uncertain and unimportance"; Quadrant IV is "Certain and unimportance".

![Figure 1. SAST method rating assumption](image)

Analysis and synthesis problems using the sectoral innovation system framework [16-17]: knowledge and technology, key actors and their linkages (industry, government, capital institutions,
universities, research and development institutions both public and private), demand conditions and institutional factors.

![Figure 2. The conventional seven stages of SSM [13].](image)

4. Results and discussion

4.1. Situational analysis

4.1.1. Supply and demand. The world's needs for manufacturing products made from raw latex materials such as gloves, rubber threads, health care industry, and others continue to increase each year. The demand for gloves in particular increases by 8-10% each year. It is estimated that the world's needs will reach 300 billion by 2030.

The production of world gloves in 2015, 2016 and 2017 is 194 billion, 211 billion and 228 billion pieces, respectively. Rubber glove production is dominated by Southeast Asian countries, especially Malaysia, Thailand, and Indonesia. The production of gloves for Malaysia, Thailand, and Indonesia is 63%, 25%, and 9%, respectively, producing approximately 97% of total world production [18]. In 2016 and 2017 Malaysia produces 134 billion and 152 billion gloves, with a target of controlling the world market share of 65% by 2020.

4.1.2. Actor and networks

4.1.2.1. Industry

The world demand for finished goods continues to increase, but it is unfortunate that Indonesian manufacturing sector is unable to compete with other countries such as Malaysia and Thailand. According to the IRGMA (Indonesian Rubber Gloves Manufacturers Association), there are 13 gloves producing companies, but currently, only 6 (six) companies are operating. In line with the decline in operating companies, Indonesia's glove production also continued to fall. In 2015, Indonesia produced 9.5 billion and in 2016 it decreased to 7.1 billion gloves [7]. The Indonesian glove market share continues to decline, from 4.9% in 2015 to 3.4% in 2016. On the other hand, the import of gloves continued to increase. The imported gloves were at 3 million kg in 2013, with a value of 19.7 million USD increased to 5.4 million kg with a value of 26.6 million USD in 2017.

Factors that affect the performance of the glove industry include: (a) Infrastructure conditions, such as roads to plantation, highways, bridges, and ports, do not support the transportation of concentrated latex to the gloves factories; (b) Logistics costs are too high that the supply of concentrated latex from domestic production is less effective and less efficient; (c) Electricity supplies, especially in North
Sumatra, problems of a reoccurring power outage and inadequate gas provision which also has no certainty. The glove factory is designed to use gas raw material since it is cleaner and more inexpensive. Given that gas prices in Indonesia are more expensive than Malaysia, the price of Indonesian glove products is not able to compete in the international market. As a comparison, the gas price in Malaysia is 4 to 6 USD/MMBTU, while in Indonesia it is about 9 to 12 USD/MMBTU. In addition, the gas sales agreement between Indonesia and China that results in a very cheap price has made the supply of gas in the country becomes difficult; (d) The alteration of energy sources from gas to palm oil shells has gone well but lately, shells have been difficult to obtain since they are exported to China for substitution of coal fuel. This scarcity causes the price of domestic shells to become more expensive; (e) Inflation is quite high, the minimum wage that rises every year and high bank interest is very influential on production costs, since the selling price cannot be increased; (f). Smallholder rubber plantations, although quite extensive, their production of concentrated latex are still not conducive due to infrastructure, roads, cultivation systems and the type of clones that are cultivated; (g) The imposition 10% VAT on the purchase of concentrated latex results in a price that is higher than the actual import price. In turn, this will reduce the performance of latex-producing plantation companies and cause import volume to increase. Imports of concentrated latex in 2013 amounted to 17,208 tons, increased to 28,067 tons in 2017, or an increase of 63%.

4.1.2.2. University and public research institute

4.1.2.2.1. Rubber research center
It is an institution that handles rubber research and development for the upstream industry, intermediate (mid) industries, and downstream industries. The rubber research center has 3 research units, namely the Sembawa Rubber Research Center, Sungai Putih Rubber Research Center, and Bogor Rubber Research Center. Rubber-based downstream industry research such as gloves, infrastructure, dock vender, bridge bearing, canal blocking, etc. are centered at the Bogor Rubber Research Center. While the other rubber research centers focus more on the activities at the upstream industry and intermediate (mid) industries.

4.1.2.2.2. Indonesian Agency of Agricultural Research and Development (IAARD)
The Indonesian Agency of Agricultural Research and Development is one of the Ministry of Agriculture's work units which functions: (1) preparation of technical policies, plans and programs for agricultural research, development and innovation; (2) conducting research, development and innovation in the agriculture field; (3) dissemination of results in agricultural research, development and innovation; (4) monitoring, evaluating and reporting the implementation of agricultural research, development and innovation. Plantation Research and Development, which is one of the IAARD work units, is currently focusing on efforts to support the two strategic programs of the Ministry of Agriculture: (1) achieving sugar self-sufficiency; (2) value-added, competitiveness, and counter negative/black campaigns related to the environment and health.

4.1.2.2.3. Industrial research and development agency
Industrial Research and Development Agency under the Ministry of Industry, which functions: (1) Preparation of technical policies, plans and programs for research, study, development and promotion in the field of industrial technology, industrial services, standardization of industries and green industries and dissemination and protection of intellectual property in industrial sector; (2) Implementation of research, study, development and promotion in the field of industrial technology, industrial services, standardization of industries and green industries and dissemination and protection of intellectual property in the industrial sector; (3) Monitoring, evaluating and reporting the implementation of research, assessment, development and promotion in the fields of industrial technology, industrial services, standardization of industries and green industries and dissemination and protection of intellectual property in the industrial sector. The priority in the research and development of natural and
cystic rubber-based industries is particularly for the tire industry, such as the development of Butadiene Rubber (BR), Styrene Butadiene Rubber (SBR), Engineering Natural rubber etc. And, Medical devices (health care) are the priority in the diversification opportunity of latex-based natural rubber products.

4.1.2.4. Research and development central agency of the ministry of public work and public housing.
Their functions: (1) Preparation of technical policies, programs and research budgets and developments in the public works and public housing field; (2) Implementation of research and development in the public works and public housing field; (3) Conducting review of policies, infrastructure development strategies, and application of technology from research and development; (4) Monitoring, evaluating and reporting the implementation of research and development in the public works and public housing field. One of the opportunities for natural rubber products diversification is infrastructure, namely the technology of solid rubber asphalt which is being researched by PUSJATAN (Center for road and bridge research). It takes political will from the government to encourage this.

4.1.2.5. University
There is no University that specifically conducts research and development for the benefit of the natural rubber industry. The university has a role as a provider of human resources needed by the industry.

4.1.2.3. Government policy and supporting organizations
The government is the determinant of the direction of the rubber industry development policy implemented through each ministry. The Ministry of Agriculture makes policies in the upstream sector such as policies for releasing and protecting varieties, licensing plantation production facilities through pesticide commissions, counseling for transfer of plantation management technologies from cultivation of nursery to post-harvest, financing schemes, government assistance to farmers, farmer institutions (in cooperation with the cooperative ministry), etc. The Ministry of Trade further regulates goods and service traffic policies and import-export rules. The existence of the ASEAN Economic Community (AEC) 2015 is a special challenge for activists of innovative industries in Indonesia. AEC agrees to (1) Asian as a single market and is based on single production supported by elements of free flow of goods, services, investment, educated labor, and freer flow of capital; (2) ASEAN as a region with high economic competitiveness, with regulatory elements for competition, consumer protection, intellectual property rights, infrastructure development, taxation, and e-commerce; (3) ASEAN as an area with equitable economic development with elements of small and medium business development, and ASEAN integration initiatives for CMLV countries (Cambodia, Myanmar, Laos, Vietnam); (4) ASEAN as a region that is fully integrated with the global economy with elements of a coherent approach to economic relations outside the region and increasing participation in global production networks. The Ministry of Industry as an authority that creates and oversees the standardization of industrial (Indonesian National Standard, etc.) and manufacturing products both upstream (mid) and downstream. The Investment Coordinating Board (BKPM) is related to industrial licensing. The Ministry of Law and Human Rights, through the directorate-general for the protection of intellectual property rights, is the authority authorized to issue patent rights as a protection against the Intellectual Property Rights of inventors/new inventions that are the forerunners of innovation. The low allocation of funds for research in Indonesia has an effect on human resources, they become less motivated to work in the research and development field.

4.1.2.4. Private sector and intermediary
The role of the association in the natural rubber industry is very important. Indonesian Rubber Glove Manufacturers Association (IRGMA) advocates gloves manufacturing. Indonesian Rubber Association (GAPKINDO) is a forum for natural rubber entrepreneurs in general, including traders. Whereas the forum for farmers is the Indonesian Rubber Farmers Association (APKARINDO). Indonesian Rubber Board (DEKARINDO) serves as a forum for all stakeholders involved in the rubber industry. DEKARINDO has a more administrative and coordinating role and has no binding authority.
Association members consisting of many entrepreneurs are dominated by traders who focus more on the market compare to manufacturing development. And most of these entrepreneurs are importers, which has more or less influenced the slowdown in the domestic manufacturing industry. Thus, the future innovation system policy that is most needed is a policy that is able to create collaboration and coordination among institutions or each actor of the innovation system. A system that attracts private sector and large scale businesses (including state-owned/regionally-owned enterprises) to develop the agricultural sector.

4.1.2.5. Financial institutions

The natural rubber industry in the upstream sector is very risky. Whereas mid industry, such as the crumb rubber industry, was once listed as a negative investment. Financing is prioritized for downstream industries that create added value. One of the problems faced by the industry is the high interest rate.

4.1.3. Knowledge and technology

The development of technology in the upstream sector such as the development of clones, plantation management and exploitation produced by the rubber research center has been relatively advanced. Weakness, especially in downstream product research and development is caused by limited research funding. The downstream industry adopts technology from other countries, especially from Malaysia and Taiwan. For example, the glove industry was originally developed in European countries. In Asia, the technology of glove production was originally developed in Taiwan, then spread to other countries such as Malaysia and Thailand. The development of the glove industry in Indonesia began in 1989 by bringing in machine tools from Europe. While Malaysia and Thailand initially used Taiwan's technology and machine tools that were more suitable for tropical countries. In 2000, Malaysia developed its own technology. In line with the increasingly diverse consumer demands, technological changes also shift. Technology development in Indonesia is still lagging behind compared to Malaysia due to various factors.

4.1.4. Institutions

In the year 2017 The Global Innovation Index places Indonesia at number 120 out of 127 countries with institutional problems. Indonesia has around 19 ministries, each of which has a stand-alone R&D institution and all have concerns about the issue of innovation. Especially for Research, Technology and Higher Education, the ministry has six autonomous institutions with LPNK (Non-Ministry Government Institutions): BAPETEN (Nuclear Energy Regulatory Agency), BATAN (National Nuclear Energy Agency), BPPT (Agency for Assessment and Application Technology), BSN (National Standardization Agency), LAPAN (National Institute of Aeronautics and Space), and LIPI (Indonesian Institute of Sciences). The ministry is still managing a number of other bodies, namely PUSPIPTEK (Research Center for Science and Technology), LBME (Eijkman Institute for Molecular Biology), PUSPA IPTEK (Demonstration Center for Science and Technology), ATP (Agro Techno Park), and BTC (Business Technology Center). In addition, there are still three institutions that are highly relevant to the innovation process in Indonesia: KEIN (National Economic and Industry Committee), KIN (National Innovation Committee), and DRN (National Research Council).

A large number of independent institutions cause the complexity of coordination. The linkages between research institutions, the development of users (industries) and the direction of government policies that are often less synchronous lead to many research results that are less attractive for the industry. Good rules often experience obstacles in their implementation. This often results from weak coordination. One of the slowdowns in the development of agricultural innovation is caused by poor cooperation between the creation system and the technology distribution system.

4.1.5. Linkage

The linkage scheme between stakeholders in the innovation system of the natural rubber industry can be explained as shown in figure 3.

In the modern system of innovation, the market demand greatly determines the direction of knowledge and technology. This was translated by technology users in the form of goods and services. Thus the system of technology users is the main driver for the dynamics of innovation. The dynamics of
Innovation will occur in the user system because technology users are active players in innovation. Interaction between technology users creates progress in innovation since users will learn from each other (learning process) [19].

![Innovation System of Natural Rubber Industry](image)

Figure 3. Innovation System of Natural Rubber Industry [19-20].

In relation to the natural rubber industry, the Rubber Research Center has found new clones that are resistant to disease, along with high production with low levels of exploitation. Funding constraints and income sustainability have caused farmers to not be able to use the technology. The limited knowledge/technology and incentives for farmers and infrastructure constraints have made it difficult for the latex-based natural rubber industry to obtain raw materials in the form of latex, which forces them to import these raw materials for the survival of the industries. Government policy related to trade, product standardization also causes the innovation process to be hampered for innovators/domestic research institutions, thus technology users are more interested in importing technology from abroad. Therefore, it is not only the interaction between user systems, intermediaries and consumers that will encourage the development of innovation for new technology, but the role of government by providing infrastructure and superstructure policies in a good economic system, and the involvement of financial institutions is also needed. In addition, the role of research institutions will be optimal if they are able to interact well with an intermediary organization that serves as a bridge between the needs of users and research institutions as creators. Interaction with external systems such as foreign research institutions, intermediary systems will greatly help strengthen interaction within the system, especially the ones that are related to the needs of new technologies, consumer preferences and the direction of policies to be implemented by a country.

4.2. Problematic situation (Exploration of strategic assumptions of designing innovation system models in the down streaming of latex-based natural rubber industry)

The mapping of the important issues related to the problems of the latex-based natural rubber industry in Indonesia is described in the form of strategic assumptions with components of factors. The strategic assumptions of the aspect factors are described in Appendix table 1. In this study, there are 7 (seven)
variables with several indicators. The seven variables are policy and regulation (REG), institutions (LGB), human resources (HR), technology (TEK), capital (FIN), industry (IND), and markets (MRK).

4.2.1. Implementation of priority considerations in policy formulation. The SAST technique is used to rank the existing assumptions. Graphically the ranks are positioned in the Cartesian quadrant so that the level of importance and certainty of the assumptions can be identified.

4.2.1.1. Policies and regulation
There are 14 (fourteen) indicators related to the policies and regulations (appendix 1). The Cartesian Quadrant of the policies and regulation indicators can be seen on figure 4.

![Figure 4. Ranking of the strategic assumptions for policies and regulation.](image)

Twelve indicators of fourteen are in the quadrant I (certain planning region) which is importance and certain namely general/main policies (REG1), Financing policies (REG2), Standardization Policies (REG4), trade policies (REG5), labor policies (REG6), industrial policies (REG7), transfer technology policies (REG9), tax policies for R and D Innovation (REG10), intellectual property rights protection Policies (REG11), government policies related to innovation systems (REG12), science and technology policies (REG 13), and education and training policies (REG14). That means these indicators become factors that must be considered by policy makers and stakeholders in developing road map solutions for the critical issues in the rubber industry in Indonesia. Two indicators, namely price policies (REG3) and research and development funding policies (REG8), are in problematic planning region (quadrant II) which is important but uncertain. That means both indicators should be evaluated and re-planning before implementation is necessary to be certain.

The main policy is related to the direction or strategy for developing the natural rubber industry, with the aim of increasing global competitiveness through changing the export structure from commodities to manufacture, with high-value addition, quality-based innovation [21]. The government's strategic plan actually has already been announced and the strategic plans of each ministry or department. But it is necessary to emphasize the concrete steps to support the industry downstreamization and the choice of products that needs to be developed. Clarity of the main plan will determine other supporting policies, such as financing policies, policies for development and technology transfer, trade policies, industry policies and standardization and human resource development policies. The lack of clarity in the policy direction from the central government will lead to low industrial competitiveness.

Problems with the implementation of policies and regulations in Indonesia include 1) The preparation of policy formulation is sectoral; 2) The process of policy formulation is less participatory; 3) The lack of understanding between policies and regulations; 4) Regulations/laws are multi-interpreted; conflict potential; overlap; discordant/out of sync; absence of implementation rules; inconsistent; and creates an
unnecessary burden on both the target group and influenced group [21]. Therefore, it is not surprising that the quality of Indonesia's regulation is not as good compared to other countries. The quality of Indonesia's regulations is only 41.7 (rank value 0 -100) with a governance score of -0.33 (ranking value of -2.5 to +2.5). While for Thailand and Malaysia, the quality of their regulations is 56.4 and 74.4, with a governance score of +0.24 and +0.66 respectively [22]. Quality of Indonesia's regulations and governance scores are still below the Philippines (43.6 and -0.26).

At the level of regulations implementation, Indonesia is also faced with debates: 1) there is no single authority agreement, 2) lack of understanding, 3) uncontrolled quantity, and 4) poor quality of the agreed regulations [22]. For example, there are up to 151 regulations in the plantation industry, which some of them overlap with each other. The lack of clarity in the long-term policy direction at the level of implementation from the central government also discourages the development of rubber agribusiness.

4.2.1.2. Institutions

There are 6 (six) indicators related to institutions (appendix 1). The Cartesian Quadrant for the institutions indicators can be seen on figure 5.

The results in figure 5 that all institutional variables are in the certain planning region (Quadrant I) which is important and certain. The six institutional indicators that need attention are institutional arrangements (LBG1), institutional effectiveness (LBG2), strengthening the network between institutions (LBG3), information, communication and cross-institutional relations (LBG4), increasing the role of research and development institutions (LBG5), financial institutions establishment (LBG6).

This means that these indicators become factors that must be considered by policymakers and stakeholders in developing road map solutions for the critical issues in the rubber industry in Indonesia.

Figure 5. Ranking of the strategic assumptions for institutions.

Strengthening the agricultural business and institutions to increase exports and value-added for agricultural products is one of the priorities in the government's activity. Government policies in regards to the rubber industry institutions are directed at the efforts to consolidate, optimize utilization and utilize the existing infrastructure resources. For farmers' organization at the regional level, the Indonesian Rubber Farmers (APKARINDO) has been formed under the auspices of the Association of Indonesian Plantation farmers (GAPPERINDO). In addition, there is also an institute of rubber research centers that has a mandate to conduct research and development related to the technology of the rubber industry [23].

Weak institutions are one of the problems that occur in rubber agribusiness. Efforts that can be done to strengthen the interaction between institutional subsystems in rubber agribusiness are to develop partnerships so that the activities of each of the actors in the rubber agribusiness system leads to a
"mutual symbiosis", as stated in agro estate and farmer cooperatives. In addition, the dynamics that occur within the institution must be well organized so that each actor can play a role in accordance with their respective functions, thus the institutional goals in the rubber agribusiness system can be achieved effectively and efficiently [24].

4.2.1.3. Human resources
There are 4 (four) indicators related to human resources (appendix 1). The Cartesian Quadrant for the human resources indicators can be seen in figure 6.

![Figure 6. Ranking of the strategic assumptions for human resources.](image)

The results in figure 6 show that all indicators on the HR factor are included in the certain planning region (Quadrant I), which is important and certain. These assumptions are SDM1 (an increase in the number of highly competent human resources), SDM2 (education and training), SDM3 (HR evaluation and standardization) and SDM4 (pride and respect for the profession), become factors that must be considered by policymakers and stakeholders in developing road map solutions for the critical issues in the rubber industry in Indonesia.

The problem of human resources in agriculture is the shifting of its human resources who decide to work outside the agricultural field and the low interest of the young generation to work in agriculture. This can be seen by the decline in the number of agricultural secondary schools and the existence of agriculture courses and training institutions [25]. The composition of human resources with undergraduate education only reached 0.1%, 0.2% with a diploma, and 7% of high school graduate [26]. In other words, while other economic sectors experience an abundance of human resources, the scarcity of human resources actually occurs in the agricultural sector. This shows a form of inconsistency between the availability of the supply of human resources and the demand from the agricultural sector, not only in the quantity dimensions but also in the dimensions of quality and suitability of human resources. The HR development strategy is a strategic action to create and higher competitiveness among agro-industry players, especially in the face of global competition and competition brought by the MEA, through various HR capacity development programs [27].

4.2.1.4. Technology
There are 6 (six) indicators related to technology (appendix 1). The Cartesian Quadrant for the technology indicators can be seen on figure 7.
The results in figure 7 show that the strategic assumptions of technology availability and innovation that are in accordance with user needs (TEK1), technology transfer to users (TEK2), responses to technological changes (cost efficiency, and productivity) (TEK3), mastery and choice of technology (TEK5), and development of technology a needed (TEK6) are included in the certain planning region (Quadrant I). This means that these indicators become factors that must be considered by policymakers and stakeholders in developing road map solutions for the critical issues in the rubber industry in Indonesia. Meanwhile, the indicator of information technology (TEK4) is in the problematic planning region (Quadrant II). That means information technology must be evaluated and re-planning before implementation is necessary to be certain.

Innovation and technology dissemination is one way to empower farmers. Technological innovations can increase agricultural production and farmers' income. However, technological innovations have not been implemented optimally. For instance, the technological innovations produced by IAARD have not been well adopted on a broad scale. This indicates that the innovation supply chain segment in the delivery subsystem and receiving subsystem is the bottleneck that causes the delaying of information delivery and the low level of the adoption of innovation produced by IAARD [28].

4.2.1.5. Capital and financial

There are 8 (eight) indicators related to capital/financial (appendix 1). The Cartesian Quadrant for those indicators can be seen in figure 8.

Figure 7. Ranking of the strategic assumptions for technology.

Figure 8. Ranking of the strategic assumptions for capital/financial.
The results show that six of eight strategic assumptions on capital/finance access factors are included in the certain planning region (quadrant I) which is important and certain. It is a particular concern for the innovative downstreamization of latex-based natural rubber policymakers. The indicators are the ease of obtaining capital access (FIN1), the amount and time period of capital utilization (FIN2), capital guarantee flexibility (FIN3), financing products and services (FIN4), financing mechanisms (FIN5), and capital institutions (FIN6), become factors that must be considered by policymakers and stakeholders in developing road map solutions for the critical issues in the rubber industry in Indonesia. Public and private R&D funding (FIN7), capital infrastructure (FIN8) is in the problematic planning region (Quadrant II). Those indicators must be evaluated and re-planning before implementation is necessary to be certain.

The availability of capital is very important in the agricultural sector, however, groups of farmers have not had sufficient capital to establish rubber processing industries. On the other hand, the loss of farmers' bargaining power in rubber buying and selling transactions is more often due to farmers' dependence on buyers to obtain a number of funds [29].

4.2.1.6. Industry

There are 6 (six) indicators related to the industry (appendix 1). The Cartesian Quadrant for the industry can be seen in figure 9.

![Figure 9. Ranking of the strategic assumptions for the industry.](image)

The results in figure 9 show that three strategic assumptions on industrial variables are included in the certain planning region (quadrant I) which is important and certain. The assumptions are, improving quality and productivity (IND1), product trading system (IND2), industrial raw materials and other supporting materials (IND4), become factors that must be considered by policymakers and stakeholders in developing road map solutions for the critical issues in the rubber industry in Indonesia. Indicators of the development of downstream industries (IND3) industrial clusters (IND5), and industry diversification (IND6) are in the problematic planning region (quadrant II) which is important but uncertain. That means that indicators must be evaluated and re-planning before implementation is necessary to be certain.

Indonesia is one of the rubber-producing countries and has become the world's rubber manufacturing base. The availability of extensive land provides an opportunity to produce more natural rubber by increasing the area of rubber plantations. Indonesia is the largest rubber producer in the world after Thailand, therefore its rubber competitiveness in the global market is also very good [30]. The contribution of the manufacturing industry to gross domestic product continued to decline, from 28.3 percent in 2004 to 21.01 percent in 2014 and became 20.16 percent in 2017. For this reason, re-industrialization is much needed, including the latex-based rubber downstream industry.
4.2.1.7. Market

There are 7 (seven) indicators related to the market (appendix). The Cartesian Quadrant for the market can be seen in figure 10.

![Figure 10. Ranking of the strategic assumptions for the market.](image)

The results in figure 10 that all market indicators are in a certain planning region (Quadrant I), which is important and certain. Market structure (MRK1), market volatility strategic assumptions (MRK2), economic growth of producer and consumer countries (MRK3), substitute goods (MRK4), global political and economic situation (MRK5), demand conditions (MRK6), and market development (MRK7) become factors that must be considered by policymakers and stakeholders in developing roadmap solutions for the critical issues in the rubber industry in Indonesia in increasing competitiveness.

Indonesia's glove market share abroad continues to decline due to the unfavorable investment climate, technology mastery, and government support. This is different from Malaysia, its promotion and marketing process has been fully supported by the government since 1990, including the support from Tun Abdul Razak research center in London. Indonesia must have policies in regards to increasing market access, expanding export markets through promotion, developing marketing information systems, periodically compiling market intelligence, creating international scale in trading capabilities, and international rubber marketing cooperation [23].

4.3. Rich picture of current problems

Based on all the studies and explanations above, the problem of latex-based natural rubber industry in Indonesia based on the system innovation perspective as a whole can be described in a rich picture as in figure 11.
At the level of innovators (R&D institutions and universities), the important factor is policy consistency, funding (incentive and facilities), human resources, copyright protection, and the information fulfillment about the direction in the change of innovation users’ needs, so that technological discovery by the innovators will be beneficial for the industry. Therefore, the interaction between users, intermediaries and innovations is indispensable.

At the level of innovation users, investment climate, infrastructure, price stability, technology and technology transfer, government policy (trade policy, tax policy, incentive policy, promotion, standardization, etc.), and financial institution support are the critical factors that policymakers should take into consideration.

The government’s weak support needs to be strengthened. Institutional elements, particularly government institutions that handle innovation need to be reinforced, empowered and simplified to facilitate coordination. Therefore, a legal direction and protection of the innovation system (such as the Innovation System Act) is an urgent necessity.

5. Conclusion and suggestion

5.1. Conclusion

The development of the manufacturing industry of the latex-based downstream product in Indonesia continues to decline and it is inversely proportional to the development of similar industries in Malaysia and Thailand. The direction of government policies that are related to manufacturing, production cost efficiency, uncertainty in the supply of auxiliary materials, electricity and gas energy, logistics and financing, business climate such as the ease of investment and financing facilities are still not optimally supported.

Almost All indicators of variable policies and regulations, institutional, human resources, technology, capital/financial, industry and markets are in the certain planning region which is important and certain that should be a concern by policymakers. Meanwhile, pricing policy, R and D financing, capital infrastructure, industrial clustering and product diversification are in problematic planning region which is important and uncertain, which should be reviewed to be more certain and directional.
It is important to highlight the interaction between innovators, intermediaries and innovation users. In addition to the interaction within the system, interactions outside the systems are also needed, such as foreign research institutions, etc. Government and financial institution support, strengthening the innovation institution and the existence of a legal direction and protection (such as the system innovation law/act) are the key factors in enhancing the innovation-based industry and increasing the industry competitiveness.

5.2. Suggestion
Further research is needed on the R and D sectoral system institution related to organization, human resources, and the relationship pattern of interaction with the business system and intermediary system. In addition, further research is needed on what types of latex-based product innovations can become the flagship product of Indonesia in the future.

References
[1] Lindung and Jamil A S 2018 Posisi Daya Saing dan Tingkat Konsentrasi Pasar Ekspor Karet alam Indonesia di Pasar Global Jurnal Agrisep 17(1) 119–28
[2] [Ditjenbun] Direktorat Jenderal Perkebunan 2015 Statistik Perkebunan, Komoditi Karet (Jakarta (ID): Dirjenbun)
[3] Gapkindo 2015 Statistik Karet Indonesia (Jakarta (ID): Gapkindo)
[4] [IRSG] International Rubber Study Group 2016 Rubber Statistic Bulletin 70 7–9 (Singapore (SG): IRSG)
[5] Weerathamrongsa P and Winai W 2013 The Rubber Industry of Thailand: a Review of Past Achievements and Future Prospects J. Agribus. Dev. Emerg. Eco. 3(1) 49–63
[6] [IRSG] International Rubber Study Group 2017 Rubber Statistic Bulletin 72 1–3 (Singapore (SG): IRSG)
[7] Dekarindo 2017 Data Statistik Industri Karet Indonesia (Jakarta (ID): Dewan Karet Indonesia)
[8] [RPN] Riset Perkebunan Nusantara 2011 Pra Studi Kelayakan Pembangunan Industri Sarung Tangan dan Benang Karet PT. Perkebunan Nusantara VIII (Persero) RPN (Bogor (ID): RPN)
[9] Bich and Nguyen N 2017 Outlook Global Demand and Supply of Natural Rubber Global Rubber Conference. (Kuala Lumpur (ML) )
[10] Ahmad M 2011 Keterpaduan Ekomi Karet alam Thailand Jurnal Ekomi 14(1) 26–37
[11] Ahmad M 2009 Sistem Agribisnis karet alam di Thailand Jurnal Sistem Agribisnis 1(1) 1–14
[12] Yap J 2010 Rubber Glove: Demand Still a Head of Supply OSK PP 10551/10/2010(025682)
[13] Checkland P B and Poulter 2006 Learning for action: A short definitive account of soft systems methodology and its use for practitioners, teachers and students (Chichester: John Wiley&Sons Ltd)
[14] Mason R O and Mitroff II 1981 Challenging strategic planning assumptions (Chichester: John Wiley and Sons)
[15] Eriyatno and Larasaty L 2013 Ilmu sistem meningkatkan integrasi dan koordinasi manajemen Jilid dua (Surabaya: Guna Wijaya)
[16] Malerba F 2005 Sectoral systems of invation: a framework for linking invation to the kwledge base structure and dynamics of sectors Econ. Innov. New Techn. 14(1–2) 63–82
[17] Intarakumnerd P, Chairatana P and Komandetdcha 2015 Invation system of the seafood industry in Thailnad Asean Journal ofTechnology Invation 23(2) 271–287
[18] [NUS] Invest Society 2015 Fundamental analysis departement rubber gloves industry report (NUS: Singapore)
[19] Mardianto S 2014 Reformasi Sistem Inovasi Pertanian di Indonesia. Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian Republik Indonesia, Jakarta
[20] Arnold E and Bell M 2001 Some New Ideas About Research for Development Future Agriculture
[21] [BAPPENAS] Kementerian Perencanaan Pembangunan Nasional. 2017. Visi Indonesia Tahun 2045, (Jakarta, ID: Badan Perencanaan Pembangunan Nasional)
[22] [BAPPENAS] Kementerian Perencanaan Pembangunan Nasional. 2013. *Pengintegrasian Kerangka Regulasi dalam Dokumen Perencanaan* (Jakarta, ID: Badan Perencanaan Pembangunan Nasional)

[23] Atika S and Afifuddin S 2015 Analisis Prospek Ekspor Karet Indonesia ke Jepang *Jurnal Ekomi Pembangunan* 3(1) 29–42

[24] Hasibuan A M, Listyati D and Prawo D 2013 Studi Model Kelembagaan dalam Sistem Agribisnis Karet *SIRINOV* 1(2) 89–97

[25] Saxena J P, Sushil and Urat P 1992 *Hierarchy and Calsifications of Program, Plant element Using Interpretative Structural Modeling System Practice* 5(6) 651–70

[26] Firdaus M 2013 *Mau Jadi Apa Setelah Lulus Lulus Sarjana Pertanian* ?. Info Kontributor Website Dirjen DIKTI, Kemendiknas. Diakses pada 27 Desember 2018. Artikel tersedia pada https://ristekdikti.go.id/kolom-opini/mau-jadi-apa-setelah-lulus-sarjana-pertanian/

[27] Fadhil R, Maarif M S, Bantacut T and Hermawan A 2017 Model Strategi Pengembangan Sumber Daya Manusia Agroindustri Kopi Gayo dalam Menghadapi Masyarakat Ekomi ASEAN *Jurnal Manajemen Tekologi* 16(2) 141–56

[28] Syakir M 2016 Pemantapan Ivasi dan Diseminasi Teklogi dalam Memberdayakan Petani *Presiding Perlindungan dan Pemberdayaan Pertanian dalam Rangka Pencapaian Kemandirian Pangan Nasional dan Peningkatan Kesejahteraan Perani*. (Jakarta (ID): BALITBANGTAN) pp 3–14

[29] Napitupulu D 2011 Kajian Tataniaga Karet alam: Upaya Peningkatan Kesejahteraan Petani *Jurnal Penelitian Karet* 29(11) 76–92

[30] Harahap N H P and Segoro B A 2018 Analisis Daya Saing Komoditas Karet alam Indonesia ke Pasar Global *Jurnal Transborder* 1(2) 130–43

### Appendix 1

**Table 2. Strategic assumptions in the innovation system models designing in downstreaming of the latex-based natural rubber industry.**

| No. | Strategic assumptions in the innovation system models designing in downstreaming of the latex-based natural rubber industry | Importance (Scale:1-7) | Certain (Scale:1-7) |
|-----|-----------------------------------------------------------------------------------------------------------------|------------------------|---------------------|
| REG1 | General/Main Policies                                                                                           | 7                      | 6                   |
| REG2 | Financing Policies                                                                                               | 7                      | 5                   |
| REG3 | Price Policies                                                                                                   | 7                      | 2                   |
| REG4 | Standardization Policies                                                                                        | 6                      | 6                   |
| REG5 | Trade Policies                                                                                                   | 6                      | 6                   |
| REG6 | Labor Policies                                                                                                   | 5                      | 5                   |
| REG7 | Industry Policies                                                                                                | 6                      | 6                   |
| REG8 | Research and Development Funding Policies                                                                      | 7                      | 3                   |
| REG9 | Transfer Technology Policies                                                                                     | 6                      | 6                   |
| REG10 | Tax Policies for Innovation R&D                                                                                    | 6                      | 5                   |
| REG11 | Intellectual Property Rights Protection Policies                                                                | 7                      | 5                   |
| REG12 | Government Policies Related to the Innovation systems                                                            | 6                      | 5                   |
| REG13 | Science and Technology Policies                                                                                  | 5                      | 5                   |
| REG14 | Education And Training Policies                                                                                  | 6                      | 5                   |
| LBG1 | Institutional Arrangements                                                                                      | 7                      | 4                   |
| LBG2 | Institutional Effectiveness                                                                                      | 6                      | 6                   |
| LBG3 | Strengthening The Network Between Institutions                                                                 | 6                      | 4                   |
| LBG4 | Information, Communication And Cross-Institutional Relations                                                   | 6                      | 5                   |
| LBG5 | Increasing The Role of Research And Development Institutions                                                   | 6                      | 6                   |
| LBG6 | Establishment of Financial Institutions                                                                          | 6                      | 6                   |
| SDM1 | Increase In The Number of Highly Competent Human Resources                                                       | 7                      | 6                   |
| SDM2 | Education and Training                                                                                          | 6                      | 4                   |
| SDM3 | HR Evaluation and Standardization                                                                               | 6                      | 4                   |
| SDM4 | Pride And Respect The Profession                                                                                 | 5                      | 4                   |
TEK1  Technology Availability And Innovation That Are In Accordance With User Needs  6  5
TEK2  Technology Transfers To Users  6  5
TEK3  Responses To Technology Transfer To Users  6  5
TEK4  Information Technology  6  3
TEK5  Mastery And Choice of Technology  6  5
TEK6  Development of Technology As Needed  7  5
FIN1  Ease of Obtaining Capital Access  7  5
FIN2  The Amount and Time Period of Capital Utilization  6  4
FIN3  Capital Guarantee Flexibility  7  4
FIN4  Financing Products And Services  5  4
FIN5  Financing Mechanisms  6  5
FIN6  Capital Institutions  6  4
FIN7  Public And Private R&D Funding  6  3
FIN8  Capital Infrastructure  7  2
IND1  Improving Quality And Productivity  6  5
IND2  Product Trading System  7  5
IND3  Development of Downstream Industry  6  2
IND4  Industrial Raw Materials And Other Supporting Materials  6  6
IND5  Industrial Clusters  6  3
IND6  Industry Diversification  6  2
MRK1  Market Structure  6  5
MRK2  Market Volatility  6  5
MRK3  Economic Growth of Producer and Consumer Countries  6  6
MRK4  Substitute Goods  6  5
MRK5  Global Political And Economic Situation  6  6
MRK6  Demand Conditions  6  6
MRK7  Market Development  6  6