AGRICULTURAL INNOVATION AND TECHNOLOGY ADOPTION FOR MELAKA'S SUSTAINABLE RUBBER INDUSTRY

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APPROVAL

"I hereby declare that I had read and go through for this thesis and it is adequate intern of scope and quality which fulfill the requirements for the awards Bachelor of Technology Management (Technology Innovation) with Honours"

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DECLARATION OF ORIGINAL WORK

I hereby declare that the work in this study is the result of my own research except ascited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree

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DEDICATION

This thesis is dedicated to my family, for the immense support and motivation throughout the whole process.

This thesis is also dedicated to my supervisor Madam Nor Ratna Binti Masrom, who had been a tremendous and wonderful guide and motivator all the way, and panel, Ts. Dr. Nurulizwa Binti Abdul Rashid supervised my research, and course mates assisted me in completing the research path.

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ABSTRACT

The rubber tree (Hevea brasiliensis) is the main source of natural rubber, an important raw material for industrial and non-industrial products. Various innovations of agricultural and technology adoption to rubber industry but still the rubber industry in Malaysia is not developing well. Furthermore, smallholders are the main producers of rubber. They account for 85% of global rubber production and more than 90% in Malaysia. The increased volatility in global rubber prices has caused a decline in Malaysian rubber production and this has adversely affected the lives of local smallholders. Adoption of a technology depends on the characteristics of the recipient (rubber smallholders), extension agents and the technology itself. This study develops the conceptual framework from the Unified Theory of Acceptance and Use of Technology (UTAUT) and technology readiness. Via interview by face to face for survey, data were collected from five farmers of rubber industry. This research explores the agricultural innovation and technology adoption for Melaka's sustainable rubber industry, whether innovation and technology adoption is related to the lack of smallholders in improving the understanding of rubber stakeholders about the effect of interaction between factors on rubber production and facilitating the formulation of smallholder-oriented policies that effective. The researcher uses qualitative methods such as interviews, some rubber tappers and relevant parties to obtain the latest information related to agricultural innovation, technology use, poverty rate issues and so on. The results showed that current policies do not effectively address issues caused by the feedback between biophysical, socioeconomic and institutional factors in the global, national and farm levels within the rubber production system. This method provides a platform to better facilitate engagement with rubber stakeholders, especially smallholders, and inform the formulation of effective smallholder-oriented policies.

Keywords: Agricultural Innovation, Technology Adoption, Rubber Industry, Smallholders, Rubber Tappers, Natural Rubber.

ABSTRAK

Pokok getah (Hevea brasiliensis) merupakan sumber utama getah asli, bahan mentah penting untuk produk industri dan bukan industri. Pelbagai inovasi penggunaan pertanian dan teknologi kepada industri getah namun industri getah di Malaysia masih tidak berkembang dengan baik. Tambahan pula, pekebun kecil merupakan pengeluar utama getah. Mereka menyumbang 85% daripada pengeluaran getah global dan lebih daripada 90% di Malaysia. Kajian ini membangunkan rangka kerja konsep daripada Teori Penerimaan dan Penggunaan Teknologi Bersepadu (UTAUT) dan kesediaan teknologi. Melalui temu bual secara bersemuka untuk tinjauan, data telah dikumpul daripada lima orang petani industri getah. Penyelidikan ini meneroka inovasi pertanian dan penggunaan teknologi bagi industri getah lestari Melaka, sama ada inovasi dan penggunaan teknologi berkaitan dengan kekurangan pekebun kecil dalam meningkatkan kefahaman pihak berkepentingan getah tentang kesan interaksi antara faktor terhadap pengeluaran getah dan memudahkan penggubalan pekebun kecil. -dasar berorientasikan yang berkesan. Pengkaji menggunakan kaedah kualitatif seperti temu bual, beberapa penoreh getah dan pihak yang berkaitan untuk mendapatkan maklumat terkini berkaitan inovasi pertanian, penggunaan teknologi, isu kadar kemiskinan dan sebagainya. Keputusan menunjukkan bahawa dasar semasa tidak berkesan menangani isu yang disebabkan oleh maklum balas antara faktor biofizikal, sosioekonomi dan institusi di peringkat global, nasional dan ladang dalam sistem pengeluaran getah. Kaedah ini menyediakan platform untuk memudahkan penglibatan dengan pihak berkepentingan getah, terutamanya pekebun kecil, dan memaklumkan penggubalan dasar berorientasikan pekebun kecil yang berkesan.

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LIST OF ABBREVIATIONS

UTeM	University Teknikal Malaysia Melaka
RISDA	Rubber Industry Smallholders Development Authority
NR	Natural Rubber
MREPC	Malaysian Rubber Export Promotion Council
GDP	Gross Domestic Product
NR	Natural Rubber
IV	Independent Variable
DV	Dependent Variable
LTC	Log Latex Clones
TPB	Theory of Planned Behavior
IR	Industrial Revolution
MRC	Malaysian Rubber Council
IT	Information Technology
TOPG	Companies including Top Glove Corp.
KPPK	The Ministry of Plantation Industry and Commodity
SUCB	Supermax Corp.
UTAUT	The Unified Theory on Acceptance and use of Technology

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The purpose of this chapter is to explore the agricultural innovation and technology adoption for Melaka's sustainable rubber industry. This chapter will also cover the research background, problem statement, research questions, research objectives, research scope, significance of study, limitations of study, and operational definition.

The history of rubber cultivation in Malaya started in the late 1877 when nine seedlings from a batch of about 2700 germinated seeds at Kew Botanic Gardens near London were dispatched and planted in Kuala Kangsar, Perak. Since the first rubber plantation in Malaya was established in 1896, the rubber industry has grown tremendously into the present Malaysia. There were 218,900 hectares of rubber planted area in Malaya in 1910 as compared to 1.066 million hectares of rubber planted area in Malaysia in 2014 (Yusoff, S., Mohamed, Z., & Ahmad, A. Z. 2019). Malaysia is the largest producer of dyed rubber products in the world. In 2020, Malaysia's natural rubber consumption for the dipping rubber product industry will amount to approximately 382 million tons.

1.2 Background of study

The natural rubber used for the dipping rubber product industry is in liquid form, which is concentrated latex that is produced through a centrifugation process. Malaysia is the seventh largest producer of natural rubber in the world in 2020 and in year 2021, the rubber sector contributes 0.2% to the country's Gross Domestic Product (GDP). In fact, Malaysia managed to make a profit of up to RM63.2 billion by October 2021 through the export of rubber and rubber products - an increase of 70.7% compared to the previous year (RISDA, 2022). Most of the intensive efforts are carried out by RISDA, considering that the majority of rubber plantations in Malaysia are rubber plantations owned by smallholders. Efforts carried out by RISDA include disbursing funds, providing training, selling the latest products and technology for rubber plants as well as channeling aid to smallholders in need. All these initiatives are implemented so that the country's production of rubber products increases and safeguards the welfare of smallholders, especially in ensuring that their rubber plants are able to generate stable income.

The adoption of technologies important, until recently, the choice of technologies available to farmers was largely determined by the need to increase production, profits and productivity. The main constraints were the availability of capital, knowledge of how to use the technology and market risks — risks that in many countries policies were shielded by government policies. In the past, “good policy practices” was therefore rather straightforward, relating primarily to increasing output and the aim of agricultural policies was to increase productivity in agriculture. Agricultural research and extension services could concentrate, for example, on improving the productivity of small farms. The sharp rise in the national wage rates also increased the cost of rubber farming activities due to high labor input requirements. These are some of the key contributing factors that have led many smallholders to make the conversion from

rubber to oil palm (Ali, M. F., Akber, M. A., Smith, C., & Aziz, A. A. 2021). Now agriculture has to fulfil diverse objectives: it needs to be internationally competitive, produce agricultural products of high quality while meeting sustainability goals.

In order to remain competitive, agricultural producers need rapid access to emerging technologies. Farmers are faced with many more constraints — and also more opportunities. In addition to being profitable, they need to meet environmental standards and regulations, as well as deal with direct and indirect consumer and lobby group pressures. They may also be flooded with information from various government and industry sources, and also that make choosing appropriate technologies more difficult. Farmers also need to change their production and management practices in response to agricultural policies that include environmental conditions.

According to MRC 2021, throughout the past eighteen months of economic turmoil due to the COVID-19 pandemic, the Malaysian rubber industry has contributed immensely to economic resilience. Going forward, it is imperative that we focus on innovation, digitalisation and technology adoption in order to devise and market problem solving solutions and products that will sustain the sector's future performance. As a leading force in the global rubber sector, Malaysian researchers have already come up with notable innovations that could help mitigate the risks to our environment and planet. Going ahead, one of MRC's key focuses will be on championing these homegrown green rubber products that can make a tremendous difference for people's wellbeing and safety as well as net-zero carbon emission targets. Among these products are rubber seismic bearings or also known as High-Damping Natural Rubber Bearings (HDNRB) for protection against earthquakes; rubberising roads using Cuplump Modified Asphalt (CMA) to prolong the lifespan of bitumen road surfaces; and Ekoprena, one of the vital components in tyres that aim to be fuel-efficient, high performing and ecologically sustainable. However, the production declined over the same time period by 46%, from 1.3 million tons to 0.6 million tons (MRB, 2020). Malaysia, which used to be the leading rubber producing country during 1960s, is now the seventh-largest rubber producer. The rubber industry is a significant contributor to the Malaysian economy, top three contributors are rubber products (USD3.7 billion), raw

rubber (USD2.8 billion) and processed rubber (USD1.6 billion) (MRB, 2020).

This is an innovation using Cuplump Modified Asphalt (CMA) to prolong the lifespan of bitumen road surfaces. CMA is a combination of bituminous cuplump, a mixture of freshly coagulated natural rubber and bitumen and asphalt, which is a common composite material used for road surfaces. Cuplump can increase the viscosity of the asphalt mixture, making it more resistant to higher temperatures, preventing cracking of road surfaces, unlike conventional road building materials that can soften and become uneven in extremely hot weather. The initial cost of CMA may be higher, but it is long-lasting and maintenance-free which makes it more economical in the long run (MRC, 2021). The decline in production is a significant concern for the national economy. The primary factors thought to be responsible for this decline are increasing volatility of global rubber prices and a prolonged period of low prices. This is believed to have led to an increase in the abandonment of rubber plantations by farmers and increased conversion of rubber plantations to other more profitable crops such as oil palm. Oil palm an plantation, offers higher wage rates and returns and are less labor-intensive compared to rubber. The sharp rise in the national wage rates also increased the cost of rubber farming activities due to high labor input requirements. These are some of the key contributing factors that have led many smallholders to make the conversion from rubber to oil palm (Ali, M. F., Akber, M. A., Smith, C., & Aziz, A. A. 2021).

Some rubber farmers leave farming altogether to pursue non-agricultural jobs (Ali, M. F., Akber, M. A., Smith, C., & Aziz, A. A. 2021). The impact of this can be seen in the decline of the total national rubber planting area by 44%, from 1.8 million hectares in 1990 to 1.0 million hectares in 2019 (MRB, 2020). The increased in farm productivity from around 1000 kg ha−1 year−1 in 1990 to 1500 kg ha−1 year-1 in 2019 (MRB, 2020) has not had a positive impact on the national rubber production, which is clear indication that the total number of active smallholders or/and harvested rubber farms have declined. This has been

the result of the shift in focus, from agriculture to manufacturing sector to diversify national revenue, back in 1950s to 1980s, by the Malaysian government. The rubber replanting program will be concentrated around the Alor Gajah and Jasin districts because the area is seen to still have many rubber plants that have the potential to be developed. Last year there was an increase of up to RM1000 for one ton. So, this rotation will also apply to rubber when the time comes.

The smallholder sector accounts for more than 80% of global rubber production Ali, M. F. B. (2021), in some countries such as Malaysia, Thailand and Indonesia, smallholders account for more than 90% of the production Ali, M. F. B. (2021). It creates employment opportunities and has a far-reaching impact on rural livelihood and poverty. The recent increase in rubber price volatility has placed many of these smallholders' livelihood at risk (MRB, 2020). Studies have also shown that prolonged low farm-gate prices have led to an increase in poor farm management by smallholders. For example, smallholders have been known to drastically reduce the number of tapping days, and more critically, some have even resorted to abandoning their nutrient management program, affecting the long-term growth and yield potential of the rubber trees. As a result of declining farm revenue, some smallholders have left rubber farming altogether and switch to crops with better returns such as oil palm or engaged in non-agricultural activities as an alternative source of income. The productivity and profitability of smallholders are heavily dependent on the support systems available through public institutions. Government of the rubber-producing countries commonly allocates specific funding to promote the growth of the rubber industry Ali, M. F. B. (2021). Various measures have been implemented by public institutions in the rubber-producing countries to assist rubber smallholders affected by low productivity and the decline in rubber prices. These measures include the provision of incentives and subsidies, development of high yielding rubber clones, introduction of enhanced intercropping techniques and the development of high value-added products (Ali, M. F. B. (2021). New initiatives include the construction of

road using rubberised bitumen and increasing downstream activities aimed at increasing internal rubber consumption and improving the rubber price.

1.3 Problem statement

Most of the rubber plantations in Malaysia are small plantations that do not generate enough income to support the life of entrepreneurs or rubber tappers. Because of this, rubber is not produced sustainably and rubber products from the country's downstream industry are exposed to the risk of social compliance in overseas markets. The cause of the decline in rubber production in Malaysia is the prolonged drop in rubber prices, in addition to the increase in the cost of living and better wages in other industries. The overall effect resulted in various disasters that affected the efforts of smallholders to continue tapping. As the existing skilled tappers age, they are no longer able to continue the heavy physical work required to cultivate their gardens and fields. Low of skilled tappers results in tree injury by less efficient tappers. Existing trees also become less productive because agronomic work is not done, such as fertilizing fields and gardens and weeding. In addition, tree diseases also plague gardeners and rubber farmers, such as pestalotiopsis leaf disease.

However, the price uncertainty in the rubber industry in the global market has caused a negative impact not only on the economy but also on smallholders. Based on the Report of the Malaysian Rubber Export Promotion Council (MREPC) in 2022 shows a rubber production fluctuation during in the first half of 2022 and (1H 2022) stood at RM15.63 billion, compared to RM39.83 billion recorded in the same period last year. In fact, the rubber industry is also facing a challenging situation when natural rubber is forced to compete with synthetic rubber. In addition, rubber production faces constraints from price fluctuation as well as uncertain weather conditions which impede procurement activities. In addition, low natural rubber prices are attributed to factors such as low crude oil prices, economic slowdown in major

importers, i.e. China, the European Union and the United States, as well as the perception of stock surplus as output exceeds demand, adds pressure to the rubber manufacturing industry (MohdFahmy-Abdullaha, Lai Wei Siengb,c, etc. 2020).

In order to maintain its important role in the Malaysian agricultural sector, the domestic rubber industry must be able to maintain its competitiveness through the efficient and effective application of inputs in the cultivation process with the aim of obtaining the maximum output possible. Therefore, the efficient use of energy in rubber cultivation needs to be looked at seriously to meet its needs. One of the ways to achieve this goal is through the determination of cultivation methods that require less energy input with higher energy productivity. In other words, rubber needs to be grown in a way where the energy input is used efficiently and effectively. This is also consistent with the effective utilization of energy in agriculture being one of the conditions for sustainable agricultural production as it leads to financial savings, better conservation of fossil fuels and lower air pollution. Looking at previous research literature, many studies about the rubber industry in Malaysia have been reported by researchers such as H A Zulekipli and D E Pebrian (2019). This past study focused on the processing, economics and future prospects of this crop. Therefore, the findings are not relevant to know the understanding of energy use in rubber cultivation.

A special attempt has been made to study energy use in various crop production systems in Malaysian agriculture. Therefore, the study of energy use in rubber cultivation in Malaysia is necessary to enrich the understanding of when, where and how much energy input is spent in this crop cultivation in the field, and ultimately to recognize the opportunity to save energy input to save operations. According to Bashier, Y.M., Ahmed, E.M., Elfaki, K.E., Thambah, S., & Khin, A.A. (2022), Natural rubber is a critical and strategic industrial raw material and will remain so in the foreseeable future and is grown primarily in landholdings that small farmers own. The natural rubber industry is vulnerable to price

fluctuations from world economic forces' changes like fundamental factors of production and consumption. There are many challenges from internal and external factors that impact comparative and competitive advantage in rubber scrap production in Malaysia (MRB, 2022).

The country's rubber industry is currently facing various challenges such as unpredictable weather, price instability and the impact of travel controls due to the COVID-19 pandemic. The sharp drop in garden production to RM2 per kilogram at the same time has a big impact on the income of tappers. The ever-increasing cost of living coupled with the goods and services tax makes the Malay community, who are on average smallholders, very depressed because their daily income is not enough to meet their family's needs. Not only in Melaka, but all over Malaysia, Tappers are not only faced with falling rubber prices but also have to deal with the problem of low tapping yield, making their lives more difficult. Although the price of rubber reached RM4 per kilogram recently, the increase failed to satisfy plantation owners and rubber tappers. According to tapper, their net income fails to reach RM1000 per month, which is the minimum wage set by the government for all workers including foreign workers.

Also according to Ali, M. F. B. (2021), in order to address the issues faced in rubber production and improve rubber smallholders' livelihood, it is crucial for smallholders to increase their productivity through improved farm management. Government agencies need to develop and implement effective smallholder oriented policies and ensure that these policies are monitored and evaluated consistently to facilitate the improvement of smallholders' farm management. However, the development of such policies requires a compilation and interpretation of a diverse and extensive set of biophysical, socioeconomic and institutional factors. The dynamic relationship between these factors that affect smallholder rubber production may further complicate the process of developing, implementing, monitoring and evaluating smallholder-oriented policies. Therefore, a comprehensive understanding of the

relationship between the different factors that affect smallholder rubber production is critical to facilitate the improvement of smallholder production and livelihood.

However, lack of study regarding the agricultural innovation and technology adoption for Melaka's sustainable rubber industry. The studies found by the researchers, most of the studies are from 2016 and years before. Studies on the agricultural innovation and technology adoption for Melaka's sustainable rubber industry are little or no similar research on the topic of this study, which hinders the credibility and scope of this research.

In conclusion, is not impossible for the farmers to restore the stability of rubber production, indirectly increasing their income and reducing the poverty rate. Therefore, stakeholders can improve rubber production performance by developing the most efficient way to plan and schedule resources and optimize productivity. One example of how agricultural innovation and technology adoption does this is by using workflows that streamline business processes, carefully track employee performance, and analyse results. It is also important to increase awareness and knowledge on agricultural innovation and technology adoption for Melaka's sustainable rubber industry to increase their productivity. Therefore, this study will be conducted on the agricultural innovation and technology adoption for Melaka's sustainable rubber industry.

1.4 Research Objective

The core objectives that this research is meant to achieve include:

1. To describe rubber industry in Melaka
2. To investigate factors influencing technology usage by using UTAUT model
3. To come out model of acceptance technology rubber industry in Melaka

1.5 Research Question

The research explores the following key questions:

RQ1: What is the rubber industry in Melaka?

RQ2: What is meant by investigating the factors that influence the use of technology by using the UTAUT model?

RQ3: How to come out model of acceptance technology rubber industry in Melaka?

1.6 Scope of research

The research's scope is the distribution of questionnaires to analyse the agricultural innovation and technology adoption for Melaka's sustainable rubber industry. Respondents will consist of RISDA and the rubber tappers. The study also focused on respondents who have knowledge about the development of technology and innovation in the rubber industry because they are more responsible in making any decisions taken.

This research will use various the journals, theories, articles and so on. The study found that the journal hypothesis and theory have been a source of information related the agricultural innovation and technology adoption for Melaka's sustainable rubber industry, also allows us to understand knowledge about the current development of the rubber sector in Malaysian. Furthermore, it provides important information on the advantages of the rubber industry after being applied to innovation and technology adoption.

Moreover, qualitative studies can explain and justify in detail how the acceptance of innovation, modern technology and issues related to rubber production. Therefore, further research is suggested to comprehensively plan the growth of the rubber industry in Malaysia.

1.7 Theoretical Contribution

To explain and predict users' technology use behavior, eight theoretical models, such as Theory of Planned Behavior (TPB), rational behavior theory, technology acceptance model and innovation diffusion theory, have been put forward in academic circles. However, it is found in the practical application that the eight models have different focuses, with problems of single perspective and incomplete elements in the study of technology use intention and behavior, which greatly reduces the explanatory power of the model (Dongsheng, L. I., & Yulian, Y. U. A. N. 2021). Therefore, Venkatesh organically integrated eight models to construct an UTAUT model, which contains four core indicators, namely performance expectation, effort expectation, social influence and convenience, among which the first three affect actual behavior by influencing behavior will, while the last one directly affects actual behavior. Scholars tested UTAUT and found that compared with the previous models' 17%-53% interpretation ability of user behavior, the interpretation ability of the new model was significantly improved to 70%, indicating that UTAUT was significantly better than the eight separate models in the analysis and prediction of user's technology use behavior and little bit of UTAUT 2 about perceived risk.

1.8 Limitation of study

In this research, limitations were influences beyond the researcher's control. Therefore, there are various limitations to conducting this research, including time limits, limited geographical area, limited number of respondents, and honesty of respondents. RISDA and the rubber tappers is respondents are the main focus in this research. The results are more focused on rubber industry than respondents from other industries. Furthermore, the researcher will only have three to four months to collect

data. The honesty of the respondents when answering the questionnaire regarding their experience or knowledge on the impact of the agricultural innovation and technology adoption for Melaka's sustainable rubber industry is one of the limitations in this research.

1.9 Chapter summary

Conclusion for this chapter, researcher had completed discuss about the background of research which is related to The Rubber Industry in Malaysia, and problem statement. The problem statement in this study was determined by researcher in order to identify research questions and research objectives have been presented in this chapter. Furthermore, researcher also explained about the various limitations to doing this research, such as a restricted number of respondents, time limits, a limited geographic area, and respondent honesty. Also the purpose of this research is to investigate of the agricultural innovation and technology adoption for Melaka's sustainable rubber industry. The importance of this study is that it provides information on of the agricultural innovation and technology adoption for Melaka's sustainable rubber industry. It will also help companies understand of the agricultural innovation and technology adoption that can improve Melaka's sustainable rubber industry.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, researcher focused on the literature review and relevant theoretical model. The thing discussed by the researcher is the variables, measurement and definition of the agricultural innovation, technology adoption of rubber industry, Melaka's sustainable rubber industry. The independent variable the agricultural innovation, technology adoption of rubber industry is clearly defined it. The dependent variable, Rubber industry is defined according to previous literature. After that, the relationships between the variables such as Rubber industry, the agricultural innovation and technology adoption for Melaka's sustainable rubber industry are clearly identified. Finally, the hypothesis of the research constructed.

2.2 Underlying Theories

2.2.1. UTAUT model

This study examines the relationship between the UTAUT model, the agricultural innovation, and the rubber industry. After reviewing different UTAUT was proposed by Xie, K., Zhu, Y., Ma, Y., Chen, Y., Chen, S., & Chen, Z. (2022), analyze research on the adoption of information technology. Reviewing eight classical adoption theories (the task-technology fit model, the diffusion of innovation theory, the theory of rational action, the theory of planned action, the technology adoption model, the theory of planned action model, the motivational model, and social cognitive theory), facilitating factors, the degree to which the

internal and external conditions of the individual's expected use of the technology promote their use of the technology. UTAUT is widely accepted in the field of social research because of its explanatory power (up to 70%).

The researcher also used a little UTAUT 2 model in this study which is related to perceived risk. Perceived risk refers to consumer uncertainty about whether the goods purchased deliver what they expect and what the seller promised. Perceived risk is a multi-dimension construct including "financial risk, physical risk, social risk, time loss risk, and psychological risk" (Qalati et al., 2021; Bangkit, Tumbuan, & Tielung, 2022). Perceived risk varies from one product category to another. Generally, it is higher in technology, and internet-related transactions as consumers are unsure whether their data will remain secure. Many studies have documented that consumers negatively perceive mobile services and online banking (Noreen et al., 2021; Sharma, Singh, & Pratt, 2022).

In recent years, in the field of agriculture, UTAUT has been widely applied to the Internet of Things, communication technology, and mobile applications, among other areas of technology-adoption intention research. However, UTAUT theory has rarely been applied in the study of tea farmers' willingness to adopt ecological agricultural technologies. In order to better understand the psychological mechanisms in play, this study introduces perceived value into the UTAUT model as a mediating variable. The extended model not only provides support for work in related fields but is also suitable for exploring the influence mechanism of perceived value on the adoption of ecological farming technology.

2.3 Technology adoption for Rubber Industry

Technology adoption requires skills in the application of technology to improve efficiency in production and commercialization, whereas product innovation requires a firm to assimilate customer need patterns in

order to design new products and services. Digital technology adoption and use in firms is associated with the ability to introduce incrementally and radically new products and services to the markets and whether the introduction of products and services of higher novelty are also related to competitive advantage in terms of higher profitability (Blichfeldt, H., & Faullant, R. 2021).

In accordance with user needs, technology transfer to users, responses to technological changes (cost efficiency, and productivity), mastery and choice of technology, and development of technology needed are included in the certain planning region. Meanwhile, the indicator of information technology is in the problematic planning region. 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 innovation supply chain segment in the delivery subsystem and receiving subsystem is the bottleneck that causes the delay of information delivery, (Kurnia, D., & Haris, U. (2020, February).

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 (Balde, B. S., Diawara, M., Rossignoli, C. M., & Gasparatos, A. 2019).

2.4 The agricultural innovation of Rubber industry

According to Kurnia, D., & Haris, U. (2020), this research will go over about the agricultural innovation of Rubber industry. 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). Furthermore, the innovations are developed so that Malaysia will become the leader in technology, environmental conservation and sustainability. This is achieved through an innovation system, which includes the relationship and cooperation between MRB and university, industry, collaborative innovative supplier and rival innovative enterprise (Kurnia, D., & Sudradjat, M. U. H. (2020). Therefore, it can be said that Malaysia has a very good innovation capacity which cause the industry to grow rapidly.

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 (Kurnia, D., & Haris, U. (2020,).

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.

2.4.1 Innovation system of the NR industry

According to Chilundo, M., De Sousa, W., Christen, E. W., Faduco, J., Bjornlund, H., Cheveia, E., ... & Van Rooyen, A. F. (2020), An AIP is a forum that brings together all the stakeholders with an interest in the irrigation scheme, creating an environment in which their roles within the larger system become self-evident and everyone understands their role in the network. The core aspect of innovation is learning. Particularly small firms, like rubber plantations, are normally dependent on support from outside the firm to implement innovations. The farmers will normally lack knowledge, expertise or resources necessary to improve yield or processing of the latex. The main emphasis is therefore on the interaction between the plantation (grower) and the supporting actor which enables the grower to implement an innovation. A central aspect of defining an innovation system for an industry, is therefore to describe the most important organizations (firms, individuals, public agencies) supporting or enabling innovation in the firms/plantations. CE Tech invests nearly three quarters of a million ringgit (MYR) annually in

Research and Development (R&D). This enables continuous innovation and the creation of products that are unique and specific to meet various end-user requirements. To drive its sustainability agenda, CE Tech prioritises the use of green technology in its manufacturing activities. Various aspects of its operations involve using green renewable energy in the form of waste woodchips to run its heaters for supplying heat energy to its production. CE Tech has also embarked on recycling the wastewater discharged from its production operations for reuse, thereby minimising the discharge of treated water to the environment, (MRC,2021).

Drawing insights from the innovation system perspective, the system of innovation as it exists today in natural rubber, which is perceived as grower centric. The innovation system is conceived as having four sub systems – the R&D sub system, extension or training and regulatory sub system, marketing and processing subsystem and finally the subsystem that include organizations like RPSs, cooperatives and other actors. Each of these subsystems interacts intensively with each other and also with the growers which in turn facilitates socially embedded learning process.

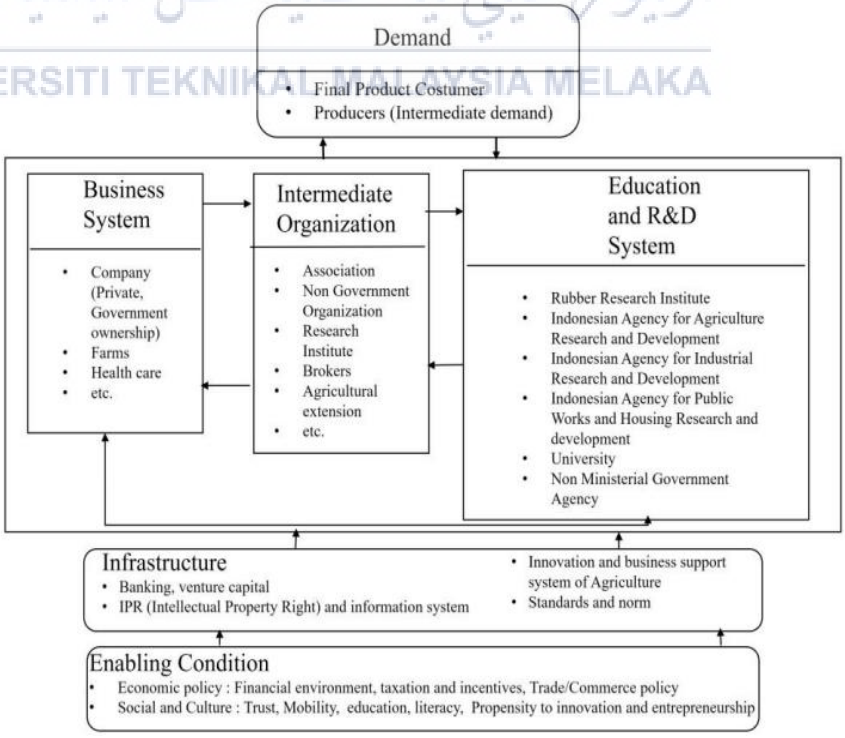

Figure 2.1: Innovation System of Natural Rubber Industry

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 (Kurnia, D., & Haris, U. 2020, February).

Table 2.1: The main publications on Rubber Industry with respect to focus and contribution

No	Author	Year	Focus	Contribution/Approach
1	Kurnia, D., & Haris, U.	2020	Critical Issue	Critical issue mapping of Indonesian natural rubber industry based on innovation system perspectives.
2	Ali, M. F. B.	2021	Opportunities	Investigating the opportunities to improve smallholder rubber production through the development of an integrated decision support system: A Malaysian case study.
3	Wee, S. M. W. J., & Singaravelloo, K.	2018	Income target and poverty	Income targets and poverty of rubber smallholders in four states of Malaysia. Planning Malaysia
4	Balde, B. S., Diawara, M., Rossignoli, C. M., & Gasparatos, A.	2019	Smallholder	Smallholder-based oil palm and rubber production in the forest region of Guinea: an exploratory analysis of household food security outcomes.
5	Kurnia, D., & Sudradjat, M. U. H.	2020	Innovation	Innovation Capacity Index Assessment of Natural Rubber Latex Based Industry: Comparative Study of Indonesia and Malaysia and Its Implications on the Development of The Industry.

2.5 Sustainable rubber industry

The rubber industry is an important resource-based sector globally. It has witnessed steady and strong growth over the years. The future and present of the rubber industry are tied to the global economy because rubber is used so often in tyres and non-tire applications. Also Rubber is used in a wide variety of products including medical equipment, surgical gloves, airplane and car tyres, clothing, toys, footwear, crap tubes, adhesives, hoses, gaskets, and roll coverings, and so on. One of the most important trends in the rubber market is the increasing demand from the automotive industry.

The rubber industry an important role in contributing to the country's economic development. The high contribution of this industry affects the landscape and the pattern of growth of the Malaysian economy. Malaysia is the world's eighth largest rubber consumer in 2016. Malaysia is also the fifth largest producer of natural rubber in the world, after Thailand, Indonesia, Vietnam and China. The increase in exports was contributed by non-latex rubber products. Exports of rubber products from Malaysia surpassed RM18 billion in 2016, registering a positive annual growth of 0.9percent. Malaysian rubber products are now exported to more than 190 countries around the world (MREPC, 2022).

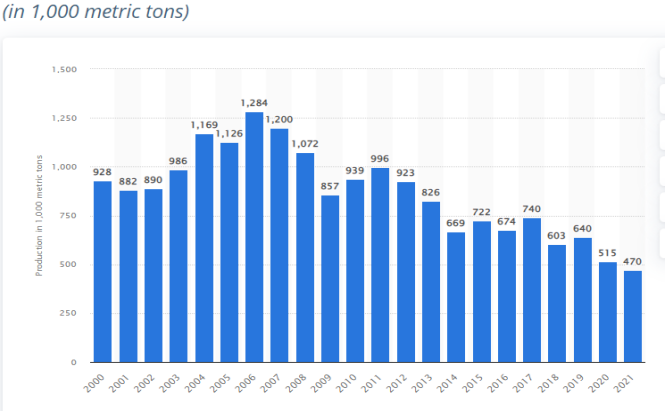

Figure 2.2: Rubber Industry From Time To Time

2.6 Rubber industry in Melaka

The decade of the 60s to the 70s witnessed the development of the agricultural sector in Melaka so vigorously. This sector is seen to be so dominant with the economic activities of the people of this state. Most of the people of Malacca are active in two main crops, namely rubber and rice. Until 1980, an area of 97,531 hectares was an area of rubber plantations, while 11,805 hectares of the area consisted of rice plantations.1 While 9,735 hectares were cultivated with fruit orchards. Although the growth of the agricultural sector developed rapidly in the early 60s and 70s, however, there are several constraints that arise in the development of this sector, including uneconomic land area, lack of agricultural infrastructure in addition to socio-economic issues that families go through agriculture such as the issue of rural population migration, especially the youth, and the increase of aging farmers. All of these problems worry the Melaka government because the agricultural sector is the main contributor to Melaka's GDP. The Malacca government is also aware that agricultural development issues require the attention of the state government as nearly 40% of the rural population consists of poor families with low incomes in this sector. (Rahmat, M. H., & Isa, S. S. M. 2019).

2.7 The factors influencing technology usage by using UTAUT model

Behavioral Intention (BI) is defined as the possibility that a person's perceived or "subjective likelihood that he or she will engage in a certain behavior". Also behavioral intention to use is referred to as an individual's decision to exhibit a particular behavior in future. It is also argued that once strength of a behavioral intention to conduct an act is greater, then it is more likely that such an act will be conducted in future (Mufidah, I., Jiang, B. C., Lin, S. C., Chin, J., Rachmaniati, Y. P., & Persada, S. F. 2018). Performance expectancy under the UTAUT model involves the

user's level of belief that the technology will improve performance in particular activities. The performance expectancy can therefore be used to determine the user's likeliness to adopt new technology. Thus, using the performance expectancy concept to determine the level of knowledge of rubber farmers related to the acceptance and use of agricultural systems and modern technology in the rubber industry (Muangmee, C., Kot, S., Meekaewkunchorn, N., Kassakorn, N., & Khalid, B. 2021).

Therefore, according to Schukat, S., & Heise, H. (2021), the determinant effort expectancy is defined as the expected effort when using a system or technology, whereby the expected effort is often perceived as higher for a new system in the initial phase. The expected effort includes both financial aspects and time. Additional effort is often associated with learning how to use and operate a system or technology rather than with the use itself. Social influence refers to the extent to which farmers perceive whether others think they should adopt system of agricultural and technology modern in industry rubber. The positive impact of the social influence on the behavioral intentions sheds light on the convincing effect of the farmers' coworkers and farmhands in persuading them to use technology modern in farming. The more the farmer's neighbors, relatives, friends, and village cadres support the farmer in adopting the new technology, the higher the farmer's willingness is. (Sun, R., Zhang, S., Wang, T., Hu, J., Ruan, J., & Ruan, J.,(2021).

However, Facilitating conditions as a construct describes the degree to which a farmer believes that organizational and technical infrastructure exists to support the farmer use of technology modern in industry rubber. A number of studies attest to and confirm the effect of facilitating conditions on the acceptance and usage of new technologies (Okumus et al. 2018). Increasing levels of facilitating conditions are expected to reduce levels of uncertainty or ambiguity with the rubber technology. (Mulugo, L., Kyazze, F. B., Kibwika, P., Kikulwe, E., Omondi, A. B., & Ajambo, S. (2020). Perceived risk (PR) refers to an individual's perception

of the potential outcomes of an action owing to his or her degree of uncertainty about a particular behavior. This is because people want to avoid losses as much as possible when making decisions in risk situations, which can be achieved through certain actions. The literature initially defined perceived risk only in terms of fraud or product quality, but today, the definition has shifted to the potential for loss in the pursuit of the desired outcome when using new technology from (Arfi, W. B., Nasr, I. B., Khvatova, T., & Zaied, Y. B. 2021).

The influences of rubber production socialized services on the rubber growers' green production of tropical cash crops. The rubber belongs to the category of trees, and the carbon storage capacity and carbon sink function of rubber forests. The green production behavior of rubber growers is affected by socialized services. Green production behavior is not only an economic behavior but also a social behavior. According to Chen, J., Zhang, D., Chen, Z., Li, Z., & Cai, Z. (2022), farmers who want to maximize income from production will increase the input of pesticides while ignoring the environmental pollution. If the long-term ecological benefits brought by green rubber production behavior cannot be reasonably weighed against the current economic costs, farmers will not adopt green production methods. Second, green agricultural production technology is more complicated than traditional production technology. New technologies increase the learning cost of farmers, which leads to a specific threshold in the process of farmers adopting green technology. Finally, under the influence of comparative advantages farmers will input labor factors into non-agricultural fields with higher output. A reduction in the sustainable input into rubber forests may lead to the input behavior not transitioning in the direction of greening. With the intensification of ASSs, the economic cost of farmers' adoption of green production behavior progressively decreases, and the degree of adoption of green production behaviors will increase.

2.8 Behavioral intention effort expectancy, performance expectancy, and perceived risk moderate and predict to use technology in rubber industry.

The Malaysian Rubber Research Institute or Rubber Research Institute, Malaysia (RRIM), which is a research agency for the country's rubber industry with a mandate to produce the latest technology, has successfully introduced various technologies to increase rubber plantation production. Among these technologies is the use of Etefon, REACTORRIM for small gardens, RRImeter, RRIMflow for farm areas and the practice of low frequency tapping systems to overcome the problem of lack of tapping energy. All these technologies need to be practiced together with basic technologies such as weed control, enemy and disease control and perfect fertilization. Therefore, among the factors influencing intention to technology in the rubber industry, there is an increasing shortage of skilled rubber tappers. The new generation avoids becoming rubber tappers because the wages are too low compared to other options. In addition, tapping traditionally requires specific skills, and the work is also heavy. Therefore, it is estimated that 50% of small rubber plantations in the country are now abandoned and not maintained. This has contributed to a significant decline in latex production.

The increase in labor costs is a serious threat to the rubber industry, because this industry requires the intensive use of labor. Therefore, something appropriate should be done so that the dependence of this sector on labor can be reduced improved. In addition large start-up costs and a lack of specialists, the technology that is available abroad, apart from being expensive, also needs to be adapted first to crops in Malaysia, especially rubber. It is necessary to prioritize the development of expertise in the country rather than adapting foreign technology because there are many different variables in the practice of agriculture in this country that may only be better understood by the local people. However, the cost is

too high like ARTs. ARTs are automatic tapping machine using a high-speed rotating cutting blade capable of producing accurate and even tapping. However, ARTs have not been able to be applied comprehensively to smallholders due to the high cost.

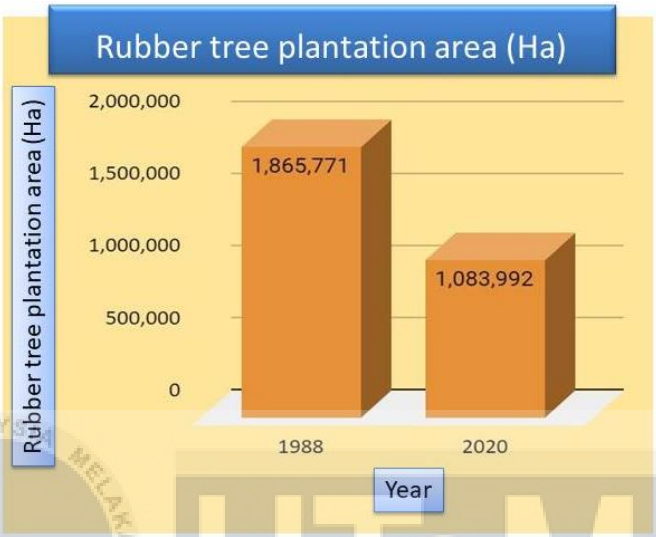

Figure 2.3: Significant decline since 2006

2.9 The resultant model empirically

Effort expectancy is a variable that greatly affects the development of plantations or rubber plantations in Malacca and in Malaysia. Therefore, various efforts have been implemented to modernize especially smallholders to increase their income. Total dependence on rubber plants alone, even with the adoption of modern technologies, is still unlikely to guarantee a satisfactory income to cover their basic needs. Many of the smallholders still face several obstacles, among the obstacles to increasing their income is the small size of the garden, the weather and the price of rubber that declines every year as well as disease and pest problems also prevent smallholders from enjoying a stable and satisfying income.

2.10 Falling rubber prices

The Ministry of Plantation Industry and Commodity (KPPK) sees the situation of falling rubber prices at the moment as a situation that directly affects small rubber farmers throughout the country and the chain involved. Rubber prices fell by 11.7percent for the period from July to August, with farm-level prices dropping to RM2.50 to RM2.80 per kilogram compared to RM3.00 per kilogram during the first six months of this year. There are several factors that cause low rubber prices. Among them is due to the sluggish global economic outlook due to slower global factory activity, the increase in global raw material and energy costs, the increase in the world's surplus of natural rubber stocks as well as the decline in the outlook for crude oil prices due to concerns about reduced oil demand due to the global economic slowdown.

According to Wee, S. M. W. J., & Singaravelloo, K. 2018, drop in rubber production had pushed up the price to its peak during 2010-11, which influenced the tire industry to raise the export prices as well. The supply-demand situation had made the rubber market itself become unstable. Rubber has been playing a key role in the socioeconomics aspect in many of the producing countries which are also developing countries. There are even over 20 million families actually dependent on the production and farming of rubber for their basic sources for the living. However, the volatility of NR price had been affecting their livelihood especially smallholders. Falling rubber price and production caused the farmers and smallholders of rubber to stop tapping due to low income. For instance, in 2016, Malaysia had been hit by a drop of almost 70% in the NR price. It was said by rubber tappers that the rubber price was falling too much too low for them to continue tapping for their living.

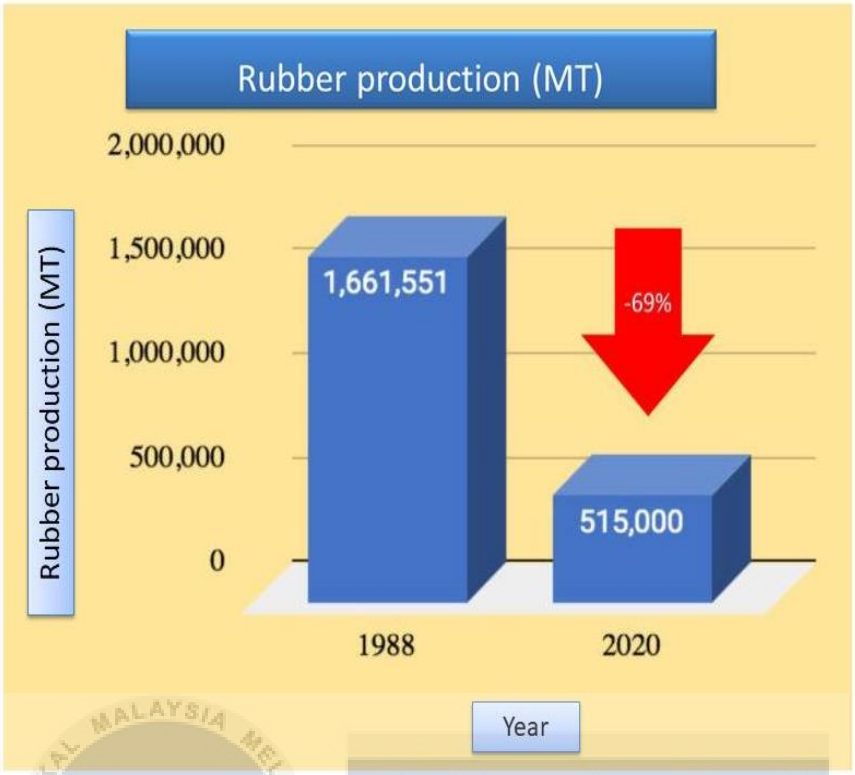

Figure 2.4: Reduction of Farmland

2.10.1 The economics and the rubber production

High global demand makes rubber a source of high economic value for smallholder income Ali, M. F. B. (2021). Smallholder income does not only contribute to economic livelihoods but can also improve smallholder quality of life and increase their social status in their community Ali, M. F. B. (2021). However, farmers are the poorest members of society, particularly in developing countries. Poverty among smallholder farmers still remains even though the agricultural sector has received substantial allocations of funding from government and aid agencies. Poverty prevails among rural rubber smallholders due to uneconomic land size, low rates of technology adoption, complicated land tenure and limited opportunities to increase revenue. These factors, coupled with adverse rubber price fluctuations, have caused financial hardship for Malaysian rubber smallholders and smallholders are highly sensitive towards the rubber 40 price—it determines their decision to tap the trees, purchase agricultural inputs, and manage on-farm weeds and diseases. Prolonged low prices can

cause smallholders to reduce or abandon rubber farming activities.

2.10.2 Planning for rubber management at a sustainable level

In the natural rubber industry, optimal sourcing means ensuring a steady supply of rubber across the long term. Achieving this depends on finding an optimal quota of planting for new plantation areas and replanting for existing plantation areas. However, neither the allocation of replanting quotas nor the total area for replanting is considered in current practice. Current approaches for planning replanting focus on the use of high quality seeds and improvement of plant density measured as the total number of rubber trees/hectare (SNR-i). In addition, the majority of available models for the planning of sourcing in literature are intended for fast growing plants, such as tomatoes and peppers, which have different characteristics to slower growing plants such as the trees used in the natural rubber industry. In this context, this paper contributes to the source planning field for tree-based products such as rubber by introducing an approach that supports the formulation of sustainable tree replanting policies using the Melaka natural rubber industry as a case study (Sitepu, M. H., Mckay, A., & Holt, R. J. 2019).

2.10.3 Environmental management in Malaysian rubber industry

According to Wee, S. M. W. J., & Singaravelloo, K. (2018) the main concern in Malaysia's natural rubber as fluctuation of market price that affects the demand, supply (productions), the quantity and the earnings from exports. Price is determined by the intersection of supply and demand. The expected rubber prices in the market, production capacity of natural rubber, input costs of natural rubber and the underlying technological progress are the determining factors for natural rubber supply. Meanwhile, income level in the overall economy, prices of rubber substitutes, price of final goods, technology, consumer preferences, stocks and manufacturing capacity take advantage of determine the demand for natural rubber. Both demand and supply actively correlate in setting

natural rubber in market. Relating to the supply and demand theory, natural rubber supply depends on several factors such as mature rubber plantation area that are eligible for tapping, the number of tapping days and rubber prices in the market. Smallholders' involvement depends on some of these. They will re-engage to tap rubber once the prices rise.

As one of the Malaysian industries that contribute significantly to the economic development of the country, the Malaysian rubber industry also generated a significant amount of waste (Sumiani Yusoff, Zameri Mohamed and Aireen Zuriani Ahmad, 2019) wastes are subjected to various regulations under the Malaysian Environmental Quality Act 1974. The open burning of rubber plantation wastes in the form of rubber tree stumps after land clearing are governed under the Environmental Quality (clean air) Regulations 1978 Part III (burning of wastes). The practice of open burning is only allowed for specific cases after obtaining special permission from Department of Environment Malaysia (DOE). The Malaysian government also gazettes the Environmental Quality (prescribed premises) of Raw Natural Rubber Regulations (1978) in making sure that all the raw effluents from the raw rubber processing activities in Malaysia are treated and meet the legal discharge standard before they are allowed to be discharged into the watercourse. The rubber products manufacturing factories in Malaysia are subjected to Environmental Quality (sewage and industrial wastes) Regulations (1979) and Environmental Quality (scheduled waste) Regulations (1989).

2.11 Theoretical Framework

The researcher focuses as a reference on UTAUT model. The research design posited in Figure 2.2, this model is obtained from Lin, C. (2019). This model is Applying the UTAUT Model to Understand Factors Affecting the Use of E-books in Fujian, China. Besides that research, as shown in model below:

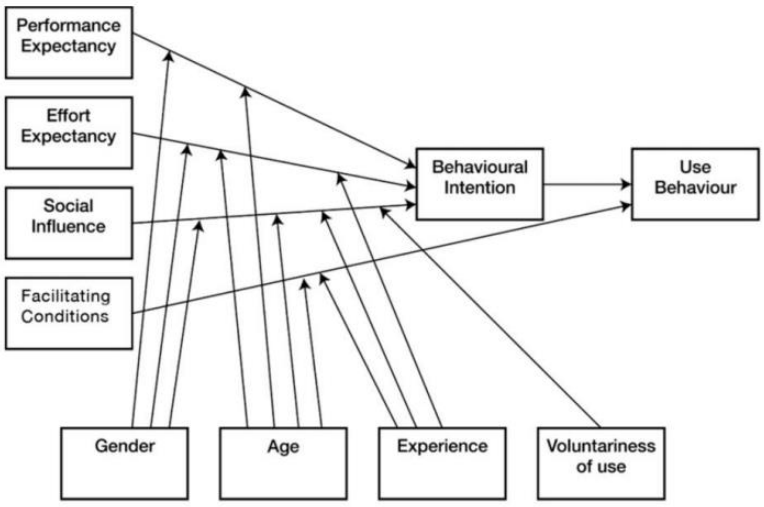

Figure 2.5: Theoretical model of the research.

Source: Lin, C. (2019)

2.12 Conceptual Framework

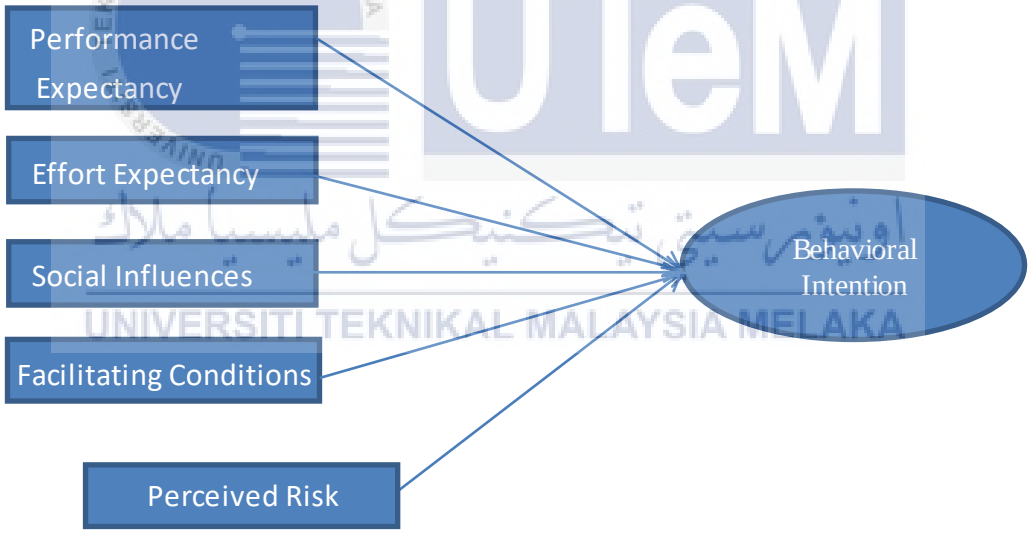

Figure 2.6: The Conceptual Framework

Adapted from: Lin, C. (2019)

Figure 2.2 shows the conceptual model of the research. Based on the: Lin, C. (2019) model, the framework also shows relationship between performance expectancy, effort expectancy, social influences, facilitating conditions, perceived risk and behavioral intention. Performance

expectancy, effort expectancy, social influences, facilitating conditions, perceived risk, a dependent variables while the independent variables are behavioral intention. Some changes are made to fit the variables for the research. Therefore, the aim of the research framework is to study the agricultural innovation and technology adoption that can improve Melaka's sustainable rubber industry.

2.13 Chapter Summary

The literature reviews that are being covered in this research topic are about the agricultural innovation and technology adoption Melaka's sustainable rubber industry. Furthermore, in this chapter, the researcher examined the definition of the rubber industry, smallholder, innovation, technology adoption on the rubber industry, all of which are based on previous research. The researcher received the studied conceptual framework from Lin, C. (2019) but modified it to suit the research variables, which included three independent variables and one dependent variable. The five independent variables are performance expectancy, effort expectancy, social influences, facilitating conditions, perceived risk and behavioral Intention as the dependent variable. Finally, the researcher developed some hypothesis testing to assess the link between the independent variables and the dependent variable.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, researcher discussed about the research methods that suitable for this study and what were the applicable methods that can be used in respond for the problem statement that discussed in Chapter 1. According to Ali, M. F. B. (2021), a literature review is conducted using a narrative method, which requires a broad reading of relevant literature, and expertise and authority of the author(s) to provide explicit narrative arguments of issues and themes of the literature. Therefore, in this chapter, researcher explained about the research methods that have been chosen by researcher in this study. In the first section researcher discussed about the research design and select an appropriate methodology choice. Following that, one of the research designs is picked for this study for a variety of impact. To complete this investigation, one of the research techniques chosen is by justification. Also, the data collection method will also outline the procedures involved in collecting data and related information. Samples and two types of samples were defined, and one of the samples would be selected for this study for a variety of reasons. Subsequently, the sample size for this study was determined, and comprehensive information of the pilot study was presented. Last but not least, data analysis techniques are described.

3.2 Research design

In this research, about the agricultural innovation and technology adoption Melaka's sustainable rubber industry was explored. According to Dannels, S. A. (2018), the research design is intended to provide an appropriate framework for a study. A very significant decision in research design process is the choice to be made regarding research approach since it determines how relevant information for a study will be obtained; however, the research design process involves many interrelated decisions. The framework for collecting and analyzing data to fulfill the research objectives and satisfy the research aims was the research design, which provided a logical justification for selecting data sources, data collection processes, and data analysis methodologies. Research design always determines the kinds of analysis that are to be done so as to get the desire results (Asenahabi, B. M. 2019).

The significance of research design lies in the fact that it permits the smooth navigation of several research methodologies, resulting in work that is as competent as is practicable, providing comprehensive data with the least amount of effort, time, and money. Four kinds of study designs exist: exploratory, descriptive, explanatory, and evaluative. The researcher has chosen exploratory research as the research strategy for this investigation.

3.2.1 Exploratory Research

Exploratory research is a methodological technique that examines research problems that have not been examined in detail before. Exploratory research is often qualitative. However, a research with a high sample size and exploratory design might also be quantitative. Due to its adaptability and open-ended character, it is also often known as interpretative research or a grounded theory method.

3.3 Methodological choice

Qualitative methods used to study the link between the agricultural innovation and technology adoption Melaka's sustainable rubber industry. The data will be gathered by the researcher using qualitative. This study is about the agricultural innovation and technology adoption Melaka's sustainable rubber industry, explore how the innovation and technology adoption of rubber industry using qualitative research methods. Qualitative research methods are rooted in the philosophical assumptions which underpin them (Bleiker, J; Morgan-Trimmer, S; Knapp, K; et al. 2019). The quality of the research is enhanced when these are transparent and clearly articulated and research quality are achieved through 3 the development of skills in both conducting research and clear communication of findings. It could be argued that the highly technical nature of medical imaging procedures justifies the predominance of objective measures of matters such as dose optimization and image quality.

The data collection methods for qualitative approach are through interviews, focus groups, case studies, and literature review while the data collection methods for quantitative approach are through surveys, experiments, observations, thematic analysis, and content analysis. Qualitative approach is used to understand something (concepts, thoughts, experience) and quantitative approach is used to confirm or test something (a theory or hypothesis).

This research uses qualitative approach to study the agricultural innovation and technology adoption Melaka's sustainable rubber industry. As for qualitative methodology, this research collects primary data from respective respondents through observation, interview session, and a case study. The observation and interview session will be carried through the respondents within the green hotel industry by narrowing the scope of respondents through case study selection. The data collected from the respondents of the selected case study through the interview session will be analyzed using thematic analysis. The analysis will be based on the research objectives and will be clustered into three themes; to investigate the factors influencing behavioral intention to technology in rubber industry (Etefon, REACTORRIM for small gardens, RRImeter, RRIMflow for farm areas and the practice of low frequency tapping systems etc.), to examine whether effort expectancy, performance expectancy, and perceived risk moderate and predict behavioral intention to use technology in rubber industry and to assess the resultant model empirically.

3.3.1 Qualitative research design

According to Leavy, P. (2022), qualitative research is generally characterized by inductive approaches to knowledge building aimed at generating meaning. Researchers use this approach to explore; to robustly investigate and learn about social phenomenon; to unpack the meanings people ascribe to activities, situations, events or artifacts; or to build a depth of understanding about some dimension of social life. The underlying qualitative research, include the importance of people's subjective experiences, meaning-making processes and acquiring a depth of understanding (i.e., detailed information from a small sample). Qualitative research is generally appropriate when the people primary purpose is to explore, describe, or explain. The use of data in qualitative

research-in order to decide which way the interpretation should move forward, or using the data to generate hypotheses and new research questions is precisely the strong asset of qualitative research (Ishtiaq, M. 2019).

The researchers use qualitative research to explore the relationship between the agricultural innovation and technology adoption Melaka's sustainable rubber industry. This is to show that this research study is qualitative and little bit quantitative to get information and, also the researcher will collect primary data using the interview and reliable questionnaire.

3.4 Data sources

The techniques of data collection were centered on getting the information required to achieve the objectives. Primary data is the information that has been collected for the first time. Furthermore, primary data provides more accurate time information. There are two sorts of information and data sources to be processed: primary and secondary. In this study, the researcher will examine both secondary and primary data sources, using a questionnaire to gather primary data for analysis and five participants were interviewed individually and took approximately an hour to allow more in-depth information to be collected. As open-ended questions were used in the interviews, it allows researcher to probe within until the saturation point is reached.

3.4.1 Primary data

Primary data is defined as the information that is developed or collected specifically for the research project. For example the primary data sources are the industry's working environment (observation and photography) and industry employees (management and bottom workers by interview, questionnaires and discussions). Specified primary data are more trustworthy and have a greater degree of confidence in the decision-

making process, with the reliable analysis being directly associated with the occurrence of events (Kassu Jilchs 2019).

The core data for the research are acquired by interviewing industry representatives on how they handle their products before distributing them to retailers. *Primary Sources:* Primary data is collected by internal report and data of The Industry Rubber Melaka and Malaysia

3.4.2 Secondary data

The majority of academics have traditionally relied on secondary data to get information for their studies. Secondary data was described as information collected by someone else in the past. In addition, secondary data are gathered by a person unconnected to the research project who collected them for a different cause and at a different time in the past and is collected by someone other than the researcher and with another purpose (Panchenko, L., & Samovilova, N. 2020).

By reading papers and scholarly publications, the researcher assessed the data pertinent to the study issue. Using the Google Scholar website, the researcher gathered secondary data to satisfy the study goals.

Secondary Sources: The secondary data is data, which is collected and compiled from different sources and are used in research for this study. The secondary data include material collected from

- Journal
- Website
- Newspaper

3.5 Location of research

The Rubber Industry in Melaka was chosen as the research location. The location is specific to small farmers in the area of Alor Gajah, Jasin, Masjid Tanah and others who have workers in the rubber

field such as rubber tappers.

3.6 Time Horizon

According to Li, D., & Zhang, X. (2019), the time horizon is the amount of time necessary to do the study. Both cross-sectional and longitudinal, the research has distinct temporal spans. Due to the limited time available for data analysis and the necessity to finish this research in a timely manner, the researcher will use a cross-sectional study to perform this investigation. The definition of a cross-sectional study is the evaluation of data at a specific point in time.

3.7 Research Strategy

The research strategy provides the general direction of the study, including the method through which the research is done. Experiment, archival research, ethnography, action research, grounded theory, narrative inquiry, survey, and case study are all research methods (Clark, J., & Causer, G. 2020). The data collection methods following qualitative strategies are often generating non-numerical data. Therefore, interviews, focus groups, case studies etc. are usually referred to as qualitative data gathering techniques and will be used in this study.

3.8 Table location of research

The location of data collection will random of the farmers on the location rubber estate which are:

The Industry Rubber Melaka	**Location**

Rubber Estate 1	Jb 1805, Jalan 8, Taman Nyalas Baru, Nyalas 77100 Asahan, Melaka. 
Rubber Estate 2	Lot 250, Kampung Bukit Senggeh, Selandar 77500 Jasin, Melaka. 

Rubber Estate 3	Tb 159, Batu 21, Tebong 76460 Alor Gajah, Melaka. 

Table 3.1: Location of research

3.9 Summary

This chapter examined the breadth of study. In addition, based on the research design, the most suitable procedures for this study were determined. According to the results of a comprehensive literature review, the integration of the agricultural innovation and technology adoption and management rubber industry success is a clearly understudied issue. Using a set of performance assessments generated based on the study, the researcher aims to evaluate this influence on performance. Consequently, interview techniques will be used to conduct an inductive research design. In other words, qualitative methodologies will be used to strengthen the study's rigor and provide more representative findings.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter highlights the findings derived from the research and presents a detailed analysis on the qualitative data obtained on the research which aims to explore the various reasons or issues the agricultural innovation and technology adoption for Melaka's sustainable rubber industry.

4.1.1 Presentation of findings

The following qualitative data was obtained through a combination of structured and semi-structured interview questions, based on three research interview questions. For the purpose of data collection, five participants with experience working under RISDA Melaka as smallholders and rubber tappers randomly, some participants were taken at random, this is because trying to get contact numbers to interview smallholders or tappers is very difficult in Melaka. This is because most of the agricultural fields in Malacca for the rubber sector have deteriorated and are decreasing. Therefore, most farmers in Melaka are switching from rubber to oil palm farming which is now flourishing in order to increase their income.

Therefore, the researcher interviewed some rubber tappers randomly to be approached and the information collected will help to better understand their views and experiences working in the rubber industry. The study consisted of participants, namely five people working in the rubber field. All of them have no less than eight to ten years of

experience working in the rubber industry.

The participants were first contacted via mobile number. As the participants all consented to take part in the interview, the sessions were conducted by face to face. The interview sessions held through face to face with the five participants took approximately an hour. Furthermore, data was collected and analyzed using thematic analysis to be able to identify themes within the data. The data that was collected was manually transcribed into text form and these information was examined to see whether they align with the research objectives. The researcher identified recurring themes in the coding and categorization process as data was analysed within each data set and across data sets. Furthermore, during the analytical process researcher was also able to identify new themes as data sets were compared with each other. As the analysis progressed, researcher noticed that the point of saturation was reached after interviewing five of participants, thus decided not to pursue further candidates for the research study.

Table 4.1: Demographic profile of the five of participants

Participant code	Age	Position	Education Level	Marital status	Number of families
Participant: 1	56	Tapper	SPM	Married	8
Participant: 2	60	Tapper	-	Married	3
Participant: 3	57	Tapper	SPM	Married	5
Participant: 4	73	Tapper	-	Married	6
Participant: 5	24	Tapper	Bachelor's degree	Single	4

Source: Primary data

4.2. QUALITATIVE DATA FINDINGS

4.2.1. Research Question 1:

RQ1: What is the rubber industry in Melaka?

The findings from the research show that the participant's knowledge about the rubber industry in Melaka. The Malaysian Rubber Board's (MRB) Rubber Research Institute Research Station (RRIMINIS) project in Jasin is being developed following a comprehensive and holistic study, taking into account various benefits to the rubber smallholders and industry. Deputy Agriculture and Food Industry Minister said the project spanning 58.5 hectares, which was approved by the MRB in 2010, also took into account its financial impact on the government and the important fact about Jasin is that it has the highest rubber crop acreage in Melaka, covering more than 48 per cent of the areas under rubber and the number of smallholders is also higher than in other parts of the state. Also Jasin was chosen as the location of the project not because their Member of Parliament for Jasin, but because RRIMINIS has yet to be built in the southern region of Peninsular Malaysia compared to other states like Perak and Kelantan.

Participant 1: "As far as I know, the first rubber estate was established in Malacca in 1902/1903. The area of rubber cultivation began to grow until it reached its peak of 2.061 million hectares in 1979. The agricultural sector, especially natural rubber, is a commodity that also contributes to the national economy. In 2021, the rubber sector will contribute 0.2 percent to the country's Gross Domestic Product (GDP), a slight decrease compared to 2015 (0.3 percent)."

Participant 2: "The agricultural sector is no stranger to the economic development of the state of Malacca. After the country's independence, the agricultural sector is still the main heart of Melaka's economic growth, especially for rubber crops. I am long-term to ensure that the country's rubber industry remains relevant including several important technologies in the rubber goods sector. It can increase the demand for natural rubber

from the manufacturing industry while meeting the changing needs of customers from time to time".

Participant 3: "In the state of Melaka, like other states in Peninsular Malaysia, the rural agriculture is mostly cultivated by the Malays. The agricultural methods that are practiced do not give a good return so that most of the farmers are in poverty. Rubber farming is the source of income for a large number of rural residents."

Participant 4: "I saw the news from television about the authorities allocating a certain amount of money and also channeled to guide small farmers starting from the stage of cleaning the crop area, until replanting and then at the marketing stage. The rubber replanting program will be concentrated around the Alor Gajah and Jasin districts because the area is seen to still have many rubber plants that have the potential to be developed. It is not impossible that at some point, the price of rubber will rise to the highest level."

Participant 5: "My knowledge is about the implementation of agricultural development plans such as the Rubber Replanting Program since 1971 which has succeeded in increasing the output of rubber in Melaka. The implementation of group rubber replanting under the management of RISDA has created a spirit of cooperation among the participants of this plan to plant rubber. The land lots that are combined between the participants involved allow the participants to have the opportunity to use efficient modern technology such as bulldozers to economically expand their garden areas. Furthermore, the guidance from RISDA also encourages each participant in this program to use 'Etefon' to ensure that every rubber tree planted is always fertile and not susceptible to disease."

Based on the discussion above, since the 1970s, small rubber farmers have consistently earned income from rubber. The estimate of one acre of land for the output of each rubber tree is as much as 336 grams.64 While the net return for the smallholder's income was recorded as much as RM280

for the year in question. This situation was found to continue showing an increase in 1980 when the smallholders had obtained an income return for that year of RM1237.65 Therefore, the development of the rubber production situation which is influenced by various factors such as local and international market demand, government support has helped improve the standard the lives of smallholders to a better level overall.

4.2.2. Research Question 2:

RQ2: What is meant by investigating the factors that influence the use of technology by using the UTAUT model?

The findings from the research indicate that by investigating the factors that influence the use of technology adoption related pressure are significant factors that result in influencing behavioral intention, performance expectancy, effort expectancy, Social influence and Facilitating conditions to technology in rubber industry Melaka and in other states in Malaysia.

Performance expectancy

Performance Expectancy is the individual's perception that the use of technology will lead to improved performance and the individual's belief that using technology to perform different activities will benefit the user. Various significant direct effects on rubber farmers on behavioral intention to use new technologies and innovations in the rubber industry, it is assumed that the small rubber farmers believe that new technology such as RRImeter, Etefon, RRIMflow for farm areas and so on will be useful in their work leading to the justification to examine the level of use of new technology used in their daily work as a determinant in this study.

Participant 1: "I find farming systems or new technologies very useful for my work. For example, the use of information and digital technology can stimulate efficiency and help industry participants such as the tracking of rubber products obtained by smallholders that are sent to Standard Malaysian Rubber (SMR) factories. It can help manufacturers or industry participants know the chain of rubber products by smallholders as well as

help in controlling the quality of rubber produced at the SMR factory."

Participant 2: "Using agricultural tools with new technology helps me finish my work faster. The government's proposal should be continued more comprehensively in using inoculation or injection methods on rubber tree trunks to enable tapping activities to continue even in the monsoon season. This is because this method simplifies the work of small farmers, which is an inoculation system such as 'injection' or a poke near the rubber stick and there is a tube that goes into a closed container. So if it rains, he (smallholder) doesn't have to worry anymore,"

Participant 3: "Overall, I expect the adoption of new technology and innovation in the rubber industry to be very beneficial to farmers. However, the government needs to increase the use of this technology, by gathering nine experts from related industries to share their information, knowledge and experience on the importance of innovation and the support and assistance channels available for the commercialization of the product."

Participant 4: "If I use a new technology system in my daily work in the rubber industry, maybe I will increase the opportunity to increase my income. For example, the Automatic Rubber Tapping System (ARTs) which can reduce the dependence on tappers like us, as far as I know it can also increase the frequency of tapping and increase the production of latex to two tons per hectare."

Participant 5: "The use of modern technology systems in the rubber sector can reduce working time for certain activities. So by using the technology it may be possible to reduce the burden or difficulty of the small rubber farmers in Malaysia, for example in sowing seeds, tapping and more."

Proposition1: The farmers perceived performance expectancy positively influences the senior's behavioral intention believe about usage a modern technology in industry rubber.

Based on the discussion above, most rubber farmers are familiar with the advantages of modern agricultural systems or technology. However, they still use traditional methods because they cannot afford to buy modern equipment because it requires high costs. Furthermore, they also do not have skills in the use of advanced technology. They just know the advantages of the technology based on the internet, television, radio announcements and so on. Therefore, it can be suggested that the concerned parties provide assistance especially to small rubber farmers who are experiencing many financial problems or other obstacles. This is for the stability of quality rubber production, and providing more sustainable options in order to preserve the wellness of the environment to future generation.

Effort expectancy

Effort Expectation is an individual's perception of the ease of using technology. Most of the participants said that the government will continue to drive the growth and sustainability of the country's rubber industry, especially regarding labor issues. Long-term research to ensure the country's rubber industry remains relevant includes several important technologies in the rubber goods sector. It can increase the demand for natural rubber from the manufacturing industry while meeting the changing needs of customers over time.

Participant 1: "I found that the new system or technology in the rubber field is flexible to interact with. Many things change with the passage of time, various types of facilities and modern technology to facilitate the affairs of all parties and with these technological tools, farmers can do their daily activities more easily, quickly and effectively and are fully used by them."

Participant 2: "Using modern technology gives me a stress factor. I have no skills in using the technology and it is difficult for me to understand everything that has been taught in using the tool. I prefer to use the old method which is the traditional method, this is because it does not make my head dizzy and makes my work easier as usual and the tools used such as a carving knife are also easy to use."

Participant 3: "I don't know how to use the farming system or the new technology. For me the use of technology requires high skills in using it and also requires knowledge of the correct way to use it from experts in the field. Furthermore, I have been used to traditional tools in my daily work as a rubber tapper for 10 years and it may be difficult for me to accept the use of new ways or methods to be applied in my usual daily work."

Participant 4: "Learning how to use modern systems or technology is difficult for me. This is because of the advancing age factor. I may not be proficient in understanding everything taught in using the new technology. Therefore, I prefer the old method because I am used to using the old method."

Participant 5: "My interaction with the modern technology used in the rubber field is clear and understandable. If the farmers earnestly learn to apply the adoption of modern technology in their daily work in the rubber industry, and with their earnestness, the use of such modern technology may increase and improve further."

Proposition 2: A farmer's perceived effort expectancy positively influences the farmer's behavioral intention about usage a modern technology in industry rubber.

Based on the discussion above, some of them experience difficulties in using modern technology equipment. One of them is because they are more accustomed to the old method or way of using a carving knife and for them the method is easier and does not require high skills to do it in daily work. Their quarter, on the other hand, recommended the farmers to change to the new method. This is because in order to produce better quality of results and not burden the farmers in carrying out their work activities, but they need a program or workshop to give them skills in using the modern technology equipment.

Social influence

Most of the participants are more inclined to use the old method which is the traditional method. This is because they are used to it and that is the norm for them. So the adoption of new technology or any innovation will change the behavior of those around them in the use of that technology, this because they are close has a stronger effect.

The first impression of the participants about new technology and innovation is that they are not strangers because the times are getting more advanced. So the use of the technology is widespread through radio, television, newspaper clippings and so on. It also changes their perception of the old method and it is difficult to use the new method.

Participant 1: "For me, the way of using new technology will probably provide various conveniences to the tappers and it will increase the rubber yield further. I recommend to young tappers to get skills in using new technology so that they are more efficient in applying the technology in planting or tapping rubber. I will use that technology because the proportion of my colleagues, use that technology in the rubber sector."

Participant 2: "Starting from the beginning of the knowledge about technology and innovation that is through my own children. They introduced modern technology such as Etefon, and RRIMflow for farm areas and he said the technology can make tapping work easier compared to traditional methods. I think it makes a good impact in society when I use the new technology."

Participant 3: "I once read in the newspaper on my mobile phone, that about the RRIM HYDROBESTTM technology to increase the productivity of rubber plantations. He said the technology is a water-based latex milk booster with two functions, which is to increase milk production and at the same time minimize the tapping panel from drying out. It is also an ethephon-based formulation and has been tested on various 2000 series clones and RRIM 3001 clones. However, the suggestions and opinions of my colleagues will influence my decision to use the system/technology."

Participant 4: "I lack knowledge about the use of new technology and innovation in the rubber sector. But my comrade in arms also told me a little bit about the new technology in the use of planting or tapping rubber and it makes the tapper's work easier. However, they said that they do not have high skills in using the new technology and it is quite difficult to

adapt the technology. So they choose to do planting or tapping activities using traditional methods only. I think I am more inclined to use the system/technology if my colleagues use it"

Participant 5: "My parents told me that in order to recover rubber in the form of latex that can be used in product of applications, thickening methods such as evaporation and creaming is impractical due to energy and capital cost factors. The separation technique using a membrane is also a technology using the concept of selective separation that separates materials (fractionates) through the pores of the membrane. I think if the tappers use the technology it will increase the good effect in Malaysian society."

Proposition 3: A farmer's perceived social influence positively influences the farmer's behavioral intention about usage a modern technology in industry rubber.

Based on the discussion above, modern technology or advanced technology in the rubber industry in Malaysia is no stranger to them. This is because there are many announcements from the internet, television and radio that spread about the advantages of using the technology for farmers and they also believe in the advantages of modern technology. However, most of them belong to B40 citizens who cannot afford to use advanced technology that requires quite high costs.

Facilitating conditions

State of Facilitation is the knowledge of the extent to which individuals believe that the technical and organizational infrastructure can support the use technology. New technologies or innovations are established to facilitate the farmers and are largely determined by indicators such as perceived behavior and compatibility. For example, the effective use of RRImeter to facilitate the work of tappers depends on the availability of the relevant parties in the rubber industry in Malaysia. To

determine the level of facilitating conditions that influence the use of new technology to increase the existing rubber yield higher by the tappers.

Participant 1: "I don't have the necessary resources to use modern farming systems or technology. Most of us tappers do not get enough training from the relevant parties on how to or use new technology in any planting activity or rubber fertilization activity in our rubber area."

Participant 2: "For me the agricultural system or modern technology is compatible with other technologies that the tappers use. Because the improved innovation may be easier for the tappers to use the modern technology, therefore the use of new technology and innovation has been encouraged by the superiors, but our skills in using the technology are still at an unsatisfactory level. Maybe we lack training in practicing the new technology and it's quite difficult for the lowly tappers like us."

Participant 3: "I don't have the necessary knowledge to use any of today's modern technology tools. The presence of experts in the use of technology that is not confusing becomes a barrier in the use of new technology that is not effective for learning to the subordinates in Malaysia. It is also not carried out diligently by the concerned parties in giving workshops to practice the use of new technology and so on."

Participant 4: "Using modern technology does not suit my work style. This is because of my work style which is more skilled in using old methods which are traditional methods in my daily work. If training or something like that is given later, it will be quite difficult for me because it is quite complex for me to use and accept the use of the new technology."

Participant 5: "I can get help from other people when I have problems using farming systems or modern technology. This is because various organizations or government parties are trying hard to provide the best for rubber tappers. Therefore, they should give a good focus in giving something new to the tappers about the use of new technology in the

rubber industry. However, the tappers are still comfortable and easy in doing their work using the old method. But in my opinion, farmers or tappers can accept the use of new technology and innovation, especially young farmers and tappers if they get proper and good training from the relevant parties."

Proposition 4: A farmer's perception of facilitating conditions positively influences the farmer's use behavior for a social modern technology in industry rubber.

Based on the discussion above, some organizations or parties concerned in the process to help farmers, and the relevant parties should provide early exposure to farmers in Malaysia such as holding programs or skills workshops to make them familiar and not awkward in using the new technology. With that, they will be able to apply the modern technology in planting and harvesting rubber ore more easily and effectively.

Behavioral intention

The degree to which an individual believes that he or she will engage in a given behavior, the impact of the four key constructs on use behavior and behavioral intention is moderated by gender, age, experience, and voluntariness of use in the model.

Participants 1: "I intend to use the system in the next year if there is an opportunity to use the modern technology. However, the provision of timely services needs to be held with the commitment of the parties concerned in making a large contribution, not only the adoption of agricultural innovation but also can reduce the adverse effects of climate change which causes agricultural business to become more risky. Therefore, farmers need constant guidance and support from agricultural advisors to manage agricultural risks through digital interventions."

Participants 2: “I predict I would use the system in appropriate time. In my view, agricultural advisors must be equipped with a variety of knowledge about modern technology so that they can easily change the attitudes and tendencies of the farming community. Increase pre-service and in-service training that should be planned by public and private sector management for their agricultural extension staff on a routine basis because these slots can be directly linked to farmers and can influence the use or use of modern technology in agriculture.”

Participants 3: “I plan to use the system in in my work activities. Considering the level of use of technology equipment among us, who are rubber farmers, is still not widespread, we may not have the impression that whether the value of the price affects the behavioral intention in adopting digital technology or vice versa."

Participants 4: "If there is an opportunity, I want to use the agricultural system or the modern technology tools. An important concern is the addition of new technology in Malaysia's agricultural policy so that the true potential of modern technology can be reaped to increase crop production, farm income and farmers' disaster resilience. Therefore, I hope that the results of this research will be useful for various agricultural stakeholders from the Malaysian context where advanced technology is developing in the agricultural sector in general and agricultural risk management in particular.”

Participants 5: "Modern technological equipment will be used if agriculture provides sufficient contributions and training, this is because for me modern technology can create opportunities for improved output and quality in agricultural products that meet market demand, but it also opens up the possibility to facilitate market access and distribution of agricultural products in agribusiness."

Proposition 5: A farmer's behavioral intention to will use a usage technology modern positively influences the farmer's use behavior for the industry rubber.

Based on the discussion above, In addition, behavioral intentions are influenced by social determinants and personal performance expectations in the use of modern technology. Beliefs, as well as facilitating conditions, also have an effect on behavioral intentions. Furthermore, facilitating conditions are important determinants of actual consumption behavior. In addition, consumption behavior is influenced by behavioral intention. Next it was found that the availability of technology plays an important role in the use of such advanced equipment. Moderating effects of age, work experience and farm size were identified that influenced farmers' willingness to use the modern technology equipment. This study has important management implications in ensuring that every farmer gets adequate knowledge of modern technology in the field of rubber agriculture and can help develop approaches for tailored technical solutions that meet the needs of farmers.

Table 4.2: The summary of research objective 1 (List of behavior intention implemented in the agricultural innovation and technology adoption for Melaka's sustainable rubber industry and its impact)

Research Objective	**Interview Data from Respondents**				
What is factors influencing behavioral intention to technology in rubber industry?	P1	P2	P3	P4	P5
Level of knowledge about agricultural systems and modern technology	M	M	M	M	H

Can complete work easily and faster	H	H	H	M	H
Disclosure about the correct and good use of technology	M	M	M	L	M
Assistance of organizations or parties concerned with technology tools or methods of using modern technology.	M	L	M	L	M

(H-High impact, M-Medium impact, L-Low impact)

Summarize by researcher (2023)

Indicators
P1: Participant 1
P2: Participant 2
P3: Participant 3
P4: Participant 4
P5: Participant 5

4.2.3 Research Question 3:

RQ3: How to come out model of acceptance technology rubber industry in Melaka?

Performance expectancy

Following UTAUT, the study theories the use of adoption technology, Performance Expectancy is the individual's perception that the use of technology will lead to improved performance and the individual's belief that using technology to perform different activities will benefit the user

and the findings show the performance expectations for each farmer, one of which is acceptance in using new technology and applying it in their work. But new technology is considered a thoughtful barrier for tappers to work in the rubber industry in Malaysia. This theme was recognized in the data set of all participants, as they voiced concerns about performance expectations in the use of new technologies for tap work.

Figure 4.1: The RRIM HYDROBESTTM Technology

Innovation can be described as something unique, convenient and valuable. Innovation is a term that has been adopted in various fields such as the manufacturing industry, services and including agriculture. Innovation in agriculture has changed the landscape of the country's agricultural sector. Innovation and technology have caused a transformation especially in the food agriculture sector from subsistence agriculture to commercial agriculture. The use of agricultural systems and modern technology for agricultural and plantation activities is seen to help

produce crops optimally in addition to increasing the income of agricultural entrepreneurs in this country. Therefore, figure 4.11 shows HYDROBEST RRIM technology and krip rubber processing to increase the productivity of rubber plantations. HYDROBEST's RRIM technology is a water-based latex booster with a dual function of increasing latex production and at the same time minimizing the drying out of the tapping panel. It is an ethephon based formulation and has been tested on various 2000 series clones as well as RRIM 3001 clones.

"For me, the agricultural system or modern technology is compatible with other technologies that the tappers use. Because the improved innovation may be easier for the tappers to use the modern technology", "makes me want to use this technology modern, maybe using the modern technology will make the experience and learning about smart agriculture better for me than otherwise.", and " the agricultural system or the use of new technology may increase the efficiency of today's rubber tappers in using it". - Participant 1,2 and 5

Based on the discussion above, the influence of performance expectancy on a Farmer's behavioral intention towards using modern technology will be positively by time flow and more detailed knowledge about rubber farmers is somewhat less satisfactory, however they also provide a positive view of the advantages of using agricultural systems or modern technology in the rubber industry. This will cause them to progress and develop more by using the technology. With that, they need to be exposed to the advantages of using modern technology more widely in the future. This is so that they can easily accept new methods to apply in their daily work activities.

Effort expectancy

Effort Expectation is an individual's perception of the ease of using technology. Most of the participants said that the government will continue to drive the growth and sustainability of the country's rubber industry, especially regarding labor issues. Long-term research to ensure the country's rubber industry remains relevant includes several important technologies in the rubber goods sector. It can increase the demand for natural rubber from the manufacturing industry while meeting the changing needs of customers over time.

Figure 4.2: RRIMCISION (GOLD MEDAL, ITEX 2019)

Demand for rubber for this year is expected to continue to increase, driven by high awareness post the COVID-19 pandemic including aspects related to hygiene, said the Malaysian Rubber Council (MRC). The Ministry of Plantation and Commodities (KPK) and the Malaysian Rubber Board (LGM) will work with relevant ministries and agencies to create a more strategic policy in safeguarding the welfare of small rubber farmers across the country. The KPK explained that it understands the situation experienced by smallholders, especially during the drop in rubber prices, and will therefore ensure that more thorough programs and activities are implemented in order to ease the burden on these groups. Also, the Ministry is very concerned about the issue of falling rubber prices and its impact on small rubber farmers and tappers across the country, especially

in facing life when faced with the increasing cost of living.

"But if there is an opportunity to learn modern technology, I will try to use it because I want to get more sustainable results by using the best resources from the help of the technology", "Techniques through modern technology for me it is good for rubber trees that can be well cared for such as the rubber garden fertilization and sanitation program, as far as I know it uses the recommended rubber clones...", and "As soon as I am able, I will use the modern technology while performing my duties".- Participant 2,3 and 4

Based on the discussion above, techniques through modern technology for farmer are good for rubber trees that can be well taken care of such as rubber plantation fertilization and sanitation programs, they use rubber clones that are recommended, if rubber trees are not fertilized and in an unmanaged state, forced technology like using hormones boosters (such as Ethrel type) because the bark of the tree will be damaged (dead skin) if it is used uncontrollably. The technique of tapping rubber trees using a tapping knife is the best choice for rubber tappers in Malaysia because of the factors of efficiency, durability, skill and various other types of risks that may occur. Therefore, the influence of effort expectancy on a farmer's behavioral intention towards using a modern technology will be positively by time flow and the farmers will use the farming system or the modern technology if they get enough skills from the parties concerned. With that, it can be said that they have the desire to use it but they don't have the opportunity to use the technology.

Perceived risk

Perceived risk (PR) (UTAUT 2) refers to an individual's perception of the potential outcomes of an action owing to his or her degree of uncertainty about a particular behavior. This is because people want to avoid losses as much as possible when making decisions in risk situations, which can be achieved through certain actions. The literature initially defined perceived risk only in terms of fraud or product quality, but today, the definition has shifted to the potential for loss in the pursuit of the desired outcome when using new technology. The difficulty faced by the participants is the knowledge of the difficulty of the innovation to be understood or used.

Figure 4.3: Ethephon Plus Latex Stimulant

Ethephon works as 'growth regulator' acting by releasing ethylene gas which reacts with the physiological processes of fruits and plants. It is indeed significant for the process of fruit ripening and cooking of crops. In the rubber field, using only 0.5 grams of Ethephon Plus Latex Stimulant to the tapping area of the rubber tree will help the production of latex (latex) to be abundant and slow to freeze. What is important when using this material for rubber trees is that the rubber tree must be fertilized and how often because it can cause damage to the skin (bark) of the rubber tree and

the latex will not come out if you are not good at using it. However, the difficulty faced by participants is the knowledge of the difficulty of innovation to understand or use.

"I am afraid that the use of modern technology will cause my cost of living to decrease", "Sometimes agricultural systems or modern technology a confusing. Furthermore, Low-educated production, the farmers focused on production with land titles: farmers worry about lack of access to credit or money to adapt agricultural production changes, and they care about government policy for rural development", and "I am concerned about the after sales in using modern technology". - Participant 1, 3 and 5

Based on the discussion above, the Perceived risk moderate and predict of technology modern influence on a farmer's behavioral intention toward using in industry rubber, will be moderated by the ability level of the farmers and less educated farmers with lower access to land and most of the farmers worry about unstable markets to sell their products and not only based poverty risk production but also on issues of insecurity in their fields and during their transportation product to market. It also include the various constraints and challenges faced by them such as not having high costs of implementing adaptive measures to face the risk, lack of skills, and difficulty in changing traditional methods to new methods. The high level of anxiety and worry about the success of modern technology also makes them less confident about the effectiveness of the technology.

Table 4.3: The summary of research objective 2 (List of behavior intention in the agricultural innovation and technology adoption for Melaka's sustainable rubber industry and its impact)

Research Objective	**Interview Data from Respondents**				
How to gain effort expectancy, performance expectancy, and perceived risk moderate and predict behavioral intention to use technology in rubber industry?	P1	P2	P3	P4	P5
Lack of disclosure about the knowledge of the use of modern rubber technology from the organization or party concerned	M	M	L	L	M
Modern technology will be used if there is exposure about the technology	H	H	H	M	H
It does not have high costs, lack of skills, and it is difficult to change traditional methods to new methods	H	H	H	H	H

(H-High impact, M-Medium impact, L-Low impact)

Summarize by researcher (2023)

Indicators
P1: Participant 1
P2: Participant 2
P3: Participant 3
P4: Participant 4
P5: Participant 5

4.3 SUMMARY OF CHAPTER

In this chapter, the researcher has discussed and analyzed the data from the case study the agricultural innovation and technology adoption for rubber industry. Through the primary and secondary data obtained from the research question, the sustainable practices and its impact has been able to be identified and evaluated, the knowledge gap between the farmers regarding the implementation of technology modern or agricultural system, and the relationship between technology and behavior intention. Every a knowledge of modern technology and methods of use used by farmers has brought its effects and benefits on the management and operation of the research.

To summarize, research objective 1 used the interview method and official document from the research question to investigate the factors influencing behavioral intention to technology in rubber industry (Etefon, REACTORRIM for small gardens, RRImeter, RRIMflow for farm areas and the practice of low frequency tapping systems etc.). The research objective 2 used the interview method to examine whether effort expectancy, performance expectancy, and perceived risk moderate and predict behavioral intention to use technology in rubber industry. The research objectives 3 used the interview method to assess the resultant model empirically.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the study aims to present the findings, research evaluation and conclusion derived from the whole research process. This chapter will also discuss on the research limitations and the recommendation for future studies on the agricultural innovation and technology adoption for Melaka's sustainable rubber industry. As such, the conclusion of each research objective is highlighted and discussed accordingly with the findings from Chapter 4. Initially, the research objectives of this study are:

i. To describe rubber industry in Melaka

ii. To investigate factors influencing technology usage by using UTAUT model

iii. To come out model of acceptance technology rubber industry in Melaka

These research objectives are discussed accordingly and the findings are concluded, in this chapter.

5.2 Discussion

The key aim of this research is to evaluate the agricultural innovation and technology adoption for Melaka's sustainable rubber industry, examining the gaps or obstacles that exist between the behavioral intentions and farmers regarding the level of knowledge and use of the latest technological tools, and to show their level of skill in using more modern methods of agricultural systems or technology.

The researcher starts the research with the question of, what is factors influencing behavioral intention to technology in rubber industry?

An initial broad literature review and interview were conducted on the factors influencing behavioral intention to technology in rubber industry as discussed on interview session in Chapter 4 to answer the first research question. To better answer the key research question, the researcher had conducting interviews by recording and noting every conversation from the farmers based on random tapping of rubber and different areas of the place.

Through the study on the agricultural innovation and technology adoption for Melaka's sustainable rubber industry, summary of the modern technology implemented in the rubber industry and the level of acceptance of the farmers on the use of the technology and operation is shown in Table 4.3 in Chapter 4. The knowledge of farmers about agricultural systems or modern technology, each of them has their own knowledge of how and how to use it in observing the research and the methods they always use differ according to the research question. This is because, most of them lack the cost, to use any advanced technology and their income has also declined since the price of rubber dropped 10 years ago. However, given the condition of rubber in Malacca and in Malaysia, there is less attention and the rubber sector also lacks rubber farmers. This is because the rubber yield obtained is also not profitable, causing many rubber farmers to turn into oil palm farmers, other plantations and so on.

Regarding the adoption of technology and agricultural innovation in the rubber industry has been detected in the study of rubber farmers, and each research question selected has been adopted in increasing rubber production, rubber quality, saving the farmers' work time and it has many constraints or problems due to the management, cost, surrounding context and land size. From the findings, it can be observed that most of the participants are more prefer of using traditional methods than using modern technology. Furthermore, they lack the cost and do not have high skills in the use of such modern technology.

The findings in this research are discussed based on the related research objective. The study intends to present the major findings as far as the objective is concerned. As such, the discussions and findings are explained and elaborated in three parts; Section 5.2.1 is the first research objective, i. to describe rubber industry in Melaka, Section 5.2.2 is the second research objective, ii.to investigate factors influencing technology usage by using UTAUT model. Section 5.2.3 is the third research objective, iii.to come out model of acceptance technology rubber industry in Melaka.

5.2.1 Research question 1: What is the rubber industry in Melaka?

Showing that the level of knowledge of the rubber farmers about the rubber field in Melaka, Some studies have found that the intention of users to use a technology is directly related to the difficulty of mastering the technology that if the farmer thinks it is easy to learn and use modern technology without spending too much time and energy, their intention to adopt modern technology will increase.

History of rubber in Melaka

The agricultural sector is no stranger to the economic development of the state of Melaka. After the country's independence, the agricultural

sector is still the main heart of Malacca's economic growth, especially for rubber and rice crops. This is proven through these two types of crops are the main contributors to the increase in the Gross Domestic Product (GDP) of Melaka from 1960 to 1980. Although, the initial focus of the development of the agricultural sector in Melaka was aimed at increasing the productivity of agricultural output, however, this does not mean that the Government Melaka neglected the focus on improving the social life of the rural population under the agricultural development strategy. Therefore, this study wants to highlight the extent to which the development of agriculture carried out by the Malacca Government has been able to improve the living standards of the rural population from 1957 until 1980. The year 1957 was chosen as the starting period for this study because it marked the year of national independence. While this research ended in 1980 before starting the implementation of in-situ agricultural development through the Melaka State Integrated Agricultural Development Plan in early 1981, (Rahmat, M. H., & Isa, S. S. M. 2019).

Efforts to Revive Malaysia's Rubber Industry

Malaysia is attempting to revive its rubber industry, a sector it once dominated as rival rubber producers Thailand, Indonesia and Vietnam gain ground. "The government is looking for ways to increase yields and commercialize new rubber products to rejuvenate a sector that accounted for about 6 percent of exports last year, according to rubber board data. According to Andoko, E. (2019), the government is increasing control and fostering the utilization of natural resources for the rubber plantation business to maximize its potential through improving the management structure. Furthermore, Plantation Company Development Patterns through various patterns are (a) Plantation Cooperative Business Patterns, (b) Investor Cooperative Joint Venture Patterns, (c) Cooperative Investor Joint Venture Patterns, (d) Build, Operate and Transfer Patterns, (e) State Savings Patterns, investors build a garden and/or factory and then transferred to the cooperative, and (f) Implement plantation business licensing is regulated by Decree of the Minister of Forestry and Plantation

Number.

Also to increase rubber production are optimizing the use of labor both in the context of tapping, weeding, fertilizing, controlling pests and weeds and other businesses that support the success of rubber products, improving agricultural technology, such as using superior seeds rejuvenating less productive crops through business partnerships with private companies and the state, and significant government support in providing fertilizers and encouraging farmers to increase their use (Wahab, S. A., Zaki, N. M., Rasidi, N. M. F. M., Nor, N. M., & Wahab, S. 2022). Automated rubber tapping would address Malaysia's labor challenges, though may not be an economically viable for small planters, according to the group. Smallholders, or those with less than 40 hectares (99 acres), account for 95 percent of Malaysia's production and Companies including Top Glove Corp. (TOPG) and Supermax Corp. (SUCB) have already established Malaysia as the world's biggest supplier of rubber and latex gloves. The government wants to increase the country's global market share in this sub-sector to 65 percent by 2020 from 62 percent under its economic plan.

5.2.2 Research question 2: What is meant by investigating the factors that influence the use of technology by using the UTAUT model?

From the analysis discussed in this study, proved that factor influencing behavioral intention is among the level of knowledge of each rubber farmer can be identified by this study through selected research questions, lack of skills and production costs have more or less of significant impact in the use of modern technology and agricultural systems in the rubber industry in Malacca and Malaysia. There are levels of knowledge of rubber farmers carried out by selected research questions, which are high, medium and low knowledge. The summary of factors influencing behavioral intention the farmers to technology by the selected research question in rubber industry is as shown in Table 5.1 below:

Table 5.1: The summary of research question 1 (List lack of technology adoption implemented the farmers on usage of technology modern for Melaka's sustainable rubber industry)

Factor lack of technology adoption	**System Technology**	**The technology modern**	**Level of impact**
High Cost	Yes	Yes	High
Lack of Technology Exposure	Yes	Yes	High
Integration & Training Concerns	Yes	Yes	High
Fear of Failure	Yes	Yes	High
Fear of making the wrong choice	No	Yes	Medium
Lack of awareness (e.g. the advantages of modern technology in farming)	No	Yes	Medium

Summarized by the researcher (2023)

All the things above and show factors influencing behavioral intention to technology in rubber industry which the level and factor lack of technology adoption on the farmers in the use of agricultural systems and modern technology for Melaka's sustainable rubber industry. The result showed widespread reluctance in adopting technology innovations. The

benefits of emerging technology are still not properly known. the implementation of modern technology among farmers is very slow, it not only affects the stable production of rubber, the price of rubber is also declining, but the process of work activities is also of poor quality, and many more as stated in Chapter 2. As a result, the reason for the adoption of modern technology solutions is slow, this is because most of the farmers are afraid to implement new technologies in the organization, afraid to transform into an advanced digital business & automate repetitive manual tasks and afraid to use smart systems..

Knowledge and technology, according to Kurnia, D., & Haris, U. (2020), 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.

5.2.3 Research question 3: How to come out model of acceptance technology rubber industry in Melaka?

Although the implementation of modern technology is less familiar among the farmers to the management and operations of the selected research question for Melaka's sustainable rubber industry, there seems the effort expectancy, performance expectancy, and perceived risk of the

farmers regarding the commitment to use the latest technology in the rubber field. Based on the findings, there are several effort expectancy, performance expectancy and perceived risk in Melaka's sustainable rubber industry which had been discussed previously in Chapter 4. The identified the fear of implementing a new technology in an organization, the fear of transforming into an advanced digital business & automating the repetitive manual tasks and the fear of adopting an intelligent system.

Performance Expectancy

In the context of agriculture, notions of increased productivity and time savings often prevail maintained (Ena, G. W. W., & Siewa, A. L. S, (2022), Michels et al. (2020) also supported performance expectations as having a positive effect on the behavioral intention to use the use of advanced technology in improving crop quality and protection among farmers. Performance root constructs Expectations combine relative advantage, perceived usefulness, and outcome expectations. Some studies have broadened the definition to include how the practice helps rubber plantation management. General perception of whether the practice improves farm management (Duang-Ek-Anong et al., 2019) and whether it is better than what it replaces, or important to agricultural needs (Beza et al., 2018), have sometimes been included. Therefore, shows that performance expectations can significantly encourage the use of advanced agricultural systems and technologies, and farmers attach importance to the benefits brought by the technology. Therefore, if farmers feel that the use of modern technology in the rubber industry can increase profit, they will use the technology actively. In this study, the decline in income and the decrease in the price of rubber and rising costs will lead to increased poverty rates, so these factors cause a significant lack of farmer consumption intention.

Effort Expectancy

In the context of this study, the researcher reports that farmers consider and evaluate potential ventures required to adopt agricultural systems and modern technology in the rubber industry. They then determine whether the effort required is commensurate with the benefits from adopting the technology. In addition, studies on the use of comfortable traditional methods also influence the intention to use modern technology. Also, relationships between the acceptance of modern technology on behavioral intention has been proven to be significant (Chao, 2019). For example, the adoption of modern technology has positives impact on the rubber industry when farmers think that the technology is relatively easy to use, requiring little effort to achieve the desired performance. When farmers feel bigger efforts to use innovative technology, their tendency to use technology decreases and Ena, G. W. W., & Siewa, A. L. S, (2022) also showed that the use of modern technology has a positive influence on intention to use the agricultural system, while Michels et al. (2020) suggest that the use of modern technology has positive the effect on the intention to use crop protection applications on sophisticated equipment used by farmers in Germany. In this study, the ease of use of agricultural systems and new technologies lead to farmers' willingness to use them advanced application of the rubber industry.

Perceived Risk

Based on the findings of the research question in chapter 4, researcher can hypothesize that the perceived risk in rubber farming is an important factor in the choice of using new technology and land use. The researcher expect that the higher the risk perception of rubber farming, the more likely smallholder rubber farmers will diversify their technology use if given the opportunity and their land use, thus reducing rubber specialization and increasing crop diversity. According to de Vries, M.,

Claassen, L., Mennen, M., Timen, A., etc. (2019) how people perceive risks can be characterised by two dimensions, which follow the psychometric paradigm. These two dimensions incorporate various psychometric characteristics of risk and are labelled ‘unknown’ and ‘dread/catastrophic potential’. The dimension ‘unknown’ covers characteristics such as ‘the risk is unknown to the exposed’, ‘the risk is not yet well known to science’, and ‘the risk has delayed effects’. The dread dimension covers, among others, characteristics as ‘the risk can have fatal consequences’, ‘the risk is involuntary’, ‘the risk is uncontrollable’ and ‘the risk is especially high for future generations’ To capture the impact of the perceived risk of rubber cultivation on the choice of using advanced technology equipment and rubber specialization by controlling other variables, we suggest that farmers are given adequate knowledge and skills training. This is to increase farmers' knowledge about the benefits of using modern equipment in their work: rubber farmers smallholders given the opportunity to use modern equipment such as in skills workshops or programs that can increase the efficiency and skills of farmers.

Environment

Sustainability is achieved when production of a product can be maintained at a certain level or rate. The term generally carries an environmental implication, so to be considered 'sustainable' the perpetuation of production must occur without depleting natural resources or damaging ecological balance. Rubber farming has a natural advantage in that it requires tree planting, which can help reverse the trend of deforestation and improve atmospheric quality. In Thailand, rubber production has increased alongside both the forest area and agricultural land area since the early 2000s (Tanielian, A. R. (2018), suggesting that the rubber industry may have had a net positive effect on forestry. On the other hand, when natural forests are cleared and replaced with NR plantations, as in China and Indonesia, carbon emissions can skyrocket and biodiversity can be adversely affected.

5.3 RECOMMENDATION

Strengthen awareness training and skills in the use of modern technology to farmers

Nurturing the spirit of the youth in the agricultural sector, indeed the people know that the involvement of youth in the agricultural sector is decreasing. Therefore, to overcome this problem, a thorough and robust program planning to involve youth in agriculture needs to be drawn up. For example, the following education and human development programs can be designed and implemented as follows:

1) Creating Skilled Youth Program: As an effort to encourage agricultural activities among youth in rural areas, in addition to mentoring youth through daily development activities by the agency, implementation of courses and training, granting professional status or skilled agricultural workers to youth and various assistance will help to produce competent and excellent speakers

2) Course Organization Program: Various courses that have values to interest the youth in agriculture should be organized especially for the youth. Those who will certainly bear the task of receiving the latest agricultural technology should be able to apply knowledge in terms of production and management through the courses followed. In addition, courses such as encouraging youth to work in groups and so on also need to be emphasized. What is important is that this course will take into account every stage of the youth's self-development.

3) Program of Learning Classes on Farm Management and Life Skills as Farmers: To improve the total abilities of youth who are already involved in agriculture for the aspects of agricultural management and life skills as farmers, these youth can follow classes in stages and on a part-time basis that are organized by the agricultural agency and others.

Transfer of technology: General conditions for adoption and appropriation

It is important to identify, among the total package of available technical solutions, which ones can help the smallholders to solve their main difficulties and to address their actual priorities. And therefore to understand which ones are those main priorities (more income, more free time available for other activities and economic diversification, less manpower, less costs, less inputs...), and among possible technical solutions, which ones can be transferred and which ones cannot depending on the actual local contexts.

For instance, some "high tech" tapping systems can be used to increase the yield, without changing the tapping intensity and the total inputs. It is the case of the DCA system designed in Thailand, which provides an increase of 10% cumulative yield compared to the equivalent single cut system. But such systems require a strict discipline on the tapping sequence, by alternating tapping on 2 different tapping cuts, and therefore can be transferred only to elite farmers who have understood the physiological background of the system. That is why such systems may not be taken on board by smallholders, as they are not always ready to change their practices only to improve their yield performance, as it may bring more constraints as well and does not necessarily addresses their main priorities.

5.4 Conclusion

This study shows that awareness and knowledge about the adoption of agricultural systems and the use of modern technology in the rubber industry among small farmers in this country is low due to weak development activities to promote any agricultural activity that uses advanced technology and lack of cost. Although the times are getting more advanced, the majority of respondents consider the lack of cost as something that cannot be avoided from such efforts. This study confirms that the participation of small farmers in the rubber sector is strongly influenced by economic factors. Low income, unlucky rubber yield, high cost of living, weak market structure and poorly developed supply chain are other major concerns that cause rubber farmers to turn to other occupations. It is clear that unless the economic returns from rubber are viable and competitive compared to other crops, interest in venturing into rubber may continue to be limited among smallholder farmers.

The decline in the price of rubber is a problem for farmers that rubber must face farmer. Low rubber prices cause reduced rubber income farmer. The strategy that can be applied by farmers to deal with low rubber prices is to increase the use of superior seeds when replanting old rubber, optimizing the rubber fields by modifying the wide spacing so that they can plant interspersed throughout year and increase farmers' awareness of using modern technology so that the price farmers receive is higher. In order to maintain its important role in the Malaysian agricultural sector, the domestic rubber industry must be able to maintain its competitiveness through the efficient and effective application of inputs in the cultivation process with the aim of obtaining the maximum output possible. Therefore, the efficient use of energy in rubber cultivation needs to be looked at seriously to meet its needs. One of the ways to achieve this goal is through the determination of cultivation methods that require less energy input with higher energy productivity. In other words, rubber needs to be grown in a way where the energy input is used efficiently and

effectively. This is also consistent with the effective utilization of energy in agriculture being one of the conditions for sustainable agricultural production as it leads to financial savings, better conservation of fossil fuels and lower air pollution. Looking at previous research literature, many studies about the rubber industry in Malaysia have been reported by researchers such as H A Zulekipli and D E Pebrian (2019).

5.5 Limitations of research

A number of limitations were identified in this study, which actually forms the basis for some further studies. The limitations are related to the study's methodology and resources challenges. The discussion that follows will explain these limitations and the step took to reduce the impact it could have had on the results and findings of the study.

Methodological limitation

The study was conducted through a combination of interviews, case study approaches, and document analysis. However, there are drawbacks to this method of data collection. Although the study agrees that this method is complementary and able to create a backup for the deficiency, there are still some challenges in its use that need to be addressed by the researcher. For example, the busy schedule of managers and other respondents who are involved in reporting their daily activities, the time given for the interview session is not fully used. Occasionally, due to phone calls and urgent matters, the interview session is interrupted if it has been shortened or longer. In the researcher's opinion, due to their busyness, respondents tend to answer in a hurry and without thinking about their answers. Nevertheless, the researcher has done a follow-up intervention to get further explanations and explanations to solve the issue.

Resources limitation

The implementation of ISO 26000 Standard in green hotel industry is not wellknown in Malaysia and there are only few that has implemented the standard into their operation and management. In this case, the researcher chose The Palace Hotel Kota Kinabalu and The Andaman Langkawi as the case study. However, in the researcher's opinion, the case study selected should be extended to other green hotels and resort in Malaysia. This is because the sustainable practices adopted are different due to the difference in management aims, cost, surrounding context and land size. The range of case study selection should be extended in order to gather data that covers the different factors influencing the sustainable practices adopted.

The implementation of the use of modern technology in the rubber industry is not very well known in Malaysia and there are only a few who have implemented such use in their operations and management. In this case, the researcher randomly selected the Malacca area as a case study. However, in the researcher's opinion, the selected case study needs to be expanded to other states in Malaysia. This is because the practices and methods of rubber farmers in using any state-of-the-art equipment used may be slightly different due to differences in management goals, costs, surrounding context and land size. The range of case study selection needs to be expanded to collect data that includes the level of knowledge of rubber farmers adopted.

5.6 Recommendations for further studies

The current study could serve as a starting point for many future studies regarding the agricultural innovation and technology adoption for Melaka's sustainable rubber industry. Based on the literature review, the results of the current study, the study' limitations and strength, there are recommendation for future studies, including:

5.6.1 One of the preliminary limitations of the research was the application of only one model (the UTAUT model) in this research. There are numerous technology adoption models, therefore the authors recommend to the future researchers of technology usage and acceptance to test other proposed models for IoT for the same contexts.

5.6.2 Extending the range of case study selection to cover different management aims, cost and availability, surrounding context and land size due to the various geographical factor in Malaysia.

5.6.3 Conducting a study on the obstacles or challenges and approaches of farmers in the use of modern technology and also the level of increasing their knowledge about the development of advanced technology small of farmers and rubber entrepreneurs in Malaysia.

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APPENDIX 1 – INTERVIEW QUESTIONS

SECTION A: THIS SECTION COVERS PART THE TECHNOLOGY ACCEPTANCE FACTORS IN THE FIELD OF RUBBER AGRICULTURE.

The following is a statement to elaborate on the Unified Theory of Acceptance and Use of Technology (UTAUT) where it is an integrated model used to identify user acceptance of technology. This UTAUT is studied based on 8 dimensions which are i) Performance Expectancy; ii) Effort Expectancy; iii) Social Influence; and iv) Facility Conditions; v) Hedonic Motivation; vi) Price Value; vii) Habits; viii) Intention and Behavior.

Based on your experience, please tick (√) the appropriate box to indicate your level of agreement from 1 – strongly disagree to 5 – strongly agree.

1. Performance Expectancy is the individual's perception that the use of technology will lead to improved performance.

	Performance Expectancy	**1**	**2**	**3**	**4**	**5**
i.	I find farming systems/modern technology useful for my work.					
ii.	Using modern farming systems/ technology helps me complete my work faster.					
iii.	Using modern agricultural systems/technology increases my productivity in performing my duties.					
iv.	Using modern agricultural systems/ technology on the farm will make it easier for me to do my job.					
v.	Overall, I expect the farming system/modern technology to be very beneficial.					
vi.	I consider that modern agricultural systems/technologies will be useful in my work environment.					
vii.	If I use modern farming systems/technologies, I will increase my chances of increasing my income.					

Performance Expectancy		1	2	3	4	5
viii.	Modern farming systems/ technology can free me from certain operational work.					
ix.	The use of agricultural systems/modern technology can reduce working time for certain activities.					

2. Effort Expectancy is an individual's perception of the ease of using technology.

Effort Expectancy		1	2	3	4	5
i.	Learning how to use farming systems/modern technology was easy for me.					
ii.	My interaction with modern agricultural/technological systems is clear and understandable.					
iii.	I find the farming system/modern technology easy to use.					
iv.	It is easy for me to become proficient in using modern farming systems/technologies.					
v.	I find that modern agricultural/technological systems are flexible to interact with.					
vi.	I imagine operating a modern agricultural/technological system would be difficult.					
vii.	Using farming systems/modern technology gives me a stress factor.					

3. Social Influence is the individual's perception regarding the acceptance or not accepting the use of technology influenced by others.

Social Influence		1	2	3	4	5
i.	People important to me think that I should use modern farming systems/technologies.					
ii.	People who influence my behavior suggest that I should use modern farming system/ technology.					
iii.	People whose opinions I value would prefer me to use modern farming systems/technologies.					
iv.	I think I'm more inclined to use modern farming systems/technologies if my colleagues use them.					

Social Influence		1	2	3	4	5
v.	The suggestions and opinions of my colleagues will influence my decision to use modern farming systems/technologies.					
vi.	I will use modern farming systems/technologies, because the proportion of my colleagues use of modern farming systems/technologies.					
vii.	I think it has a good effect on society when I use farming systems/ modern technology					

4. State of Convenience is the knowledge of the extent to which individuals believe that the technical and organizational infrastructure can support technology use.

Facility Conditions		1	2	3	4	5
i.	I have the necessary resources to use modern farming systems/technologies.					
ii.	I have the necessary knowledge to use farming systems/ modern technology.					
iii.	Modern farming systems/technologies are compatible with other technologies I use.					
iv.	I can get help from others when I have problems using farming systems/ modern technology.					
v.	Using farming systems/modern technology suits my work style.					
vi.	Internet access or mobile internet connection found throughout the farm.					

5. Habit is the degree to which people tend to perform automatic behavior, based on learning.

Habit		1	2	3	4	5
i.	The use of agricultural systems/modern technology has become a habit for me.					
ii.	I am obsessed with the use of farming systems/modern technology.					
iii.	I must use modern farming systems/ technology.					
iv.	Using modern farming systems/ technology is something I can do without thinking.					

6. Intention and Behavior is the behavioral tendency of an individual towards the acceptance and use of technology voluntarily.

	Intentions and Behaviors	1	2	3	4	5
i.	I intend to continue to use modern farming systems/technology when performing my duties in the future.					
ii.	I will always try to use modern farming systems/technologies in my daily work.					
iii.	I plan to continue using modern farming systems/technologies when performing my duties regularly.					
iv.	As soon as I am able, I will use modern farming systems/technology while performing my duties.					
v.	I would recommend others to use modern farming systems/ technology in carrying out their duties.					

SECTION B: THIS SECTION COVERS THE DIFFUSION OF INNOVATION

The following is a statement to describe the Perception of Innovation (Diffusion of Innovation) based on 5 dimensions which are i) Relative Advantage; ii) Compatibility; iii) Difficulty/ Convenience; and iv) Triability; v) Visibility.

Based on your experience, please tick (√) the appropriate box to indicate your level of agreement from 1 – strongly disagree to 5 – strongly agree.

1. Relative Advantage is the degree to which an innovation is seen as better than the idea, program or product it replaces.

	Relative Advantage	1	2	3	4	5
i.	Modern agricultural/technological systems are better than using labour to perform advanced agricultural/technological processes.					
ii.	Using modern agricultural systems/technology makes the experience and learning about agriculture/technology better					

	for me than otherwise.					
iii.	I learned about agriculture/modern technology more quickly and easily because of using the modern agriculture/technology system.					
iv.	Mistakes using farming systems/modern technology are easier to correct than manual ones.					
v.	Modern farming systems/technologies increase my efficiency when I use them.					
vi.	Modern agricultural systems/technologies provide greater flexibility.					
vii.	Farming/modern technology system will help solve all my farming/modern technology equipment problems in time.					

2. Compatibility refers to the extent to which the innovation is consistent with the values, experiences and needs of potential users.

	Compatibility	**1**	**2**	**3**	**4**	**5**
i.	The name "farming system/modern technology" makes me want to use this program.					
ii.	Farming systems/modern technology helped me learn more about technology while also learning about farming/modern technology.					
iii.	It bothers me to use farming systems/ modern technology when I can do my work manually.					
iv.	I am concerned about the privacy of my information when using modern farming systems/technologies.					
v.	Farming systems/modern technology is/will be compatible with all the requirements of my job performance.					
vi.	Using farming systems/modern technology suits my style of work.					

3. Difficulty / Convenience are the knowledge of the difficulty and ease of the innovation to understand or use.

	Difficulty / Convenience	**1**	**2**	**3**	**4**	**5**
i.	Using modern farming systems/technology will be challenging and frustrating.					
ii.	Learning to use farming systems/modern technology will be easy for me to master.					
iii.	Modern agricultural systems/technologies are complicated to learn.					
iv.	Modern farming/technological systems are confusing.					

4. Trialability refers to the extent to which the innovation can be tested or tested before commitment to adoption.

	Trialability	**1**	**2**	**3**	**4**	**5**
i.	Modern farming systems/technologies are readily available to get used to.					
ii.	I don't have to spend a lot of effort trying modern farming systems/technologies.					
iii.	I have not had enough opportunities to try modern farming systems/technologies.					
iv.	I like to try modern farming systems/technologies before deciding if I like them or not.					
v.	Being able to try modern farming systems/technologies was important in my decision to use them.					
vi.	It didn't take me much time to experiment with modern farming systems/technologies before accepting their use.					

5. Visibility refers to the extent to which the innovation provides tangible results.

	Visibility	**1**	**2**	**3**	**4**	**5**
i.	Being seen as a user of modern farming systems/ technology is good for my image.					
ii.	Consumers using modern farming systems/technologies are not very visible in my social circle.					
iii.	I have seen other people using farming systems/ modern technology.					

iv.	People can know that I know more about farming technology/ modern technology since I use farming system/ modern technology.					
v.	I will have no difficulty telling friends about modern farming systems/ technology.					

SECTION C: THIS SECTION COVERS THE STATE OF FACTOR (INPUT) ADOPTION OF TECHNOLOGY MODERN IN RUBBER INDUSTRY.

1. Technology
    - Does the technology available to produce the best rubber production results and can increase the quantity?
    - Does there a warehouse for storing rubber production products that uses technology that guarantees quality?
2. Financial
    - Do the capital provided sufficient to cover the cost of rubber production?

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3. Human resources
    - Are there sufficient human resources to produce rubber production?
    - Are there skilled human resources to manage rubber production efficiently? Please state alternative strategies/actions if skilled human resources are insufficient.

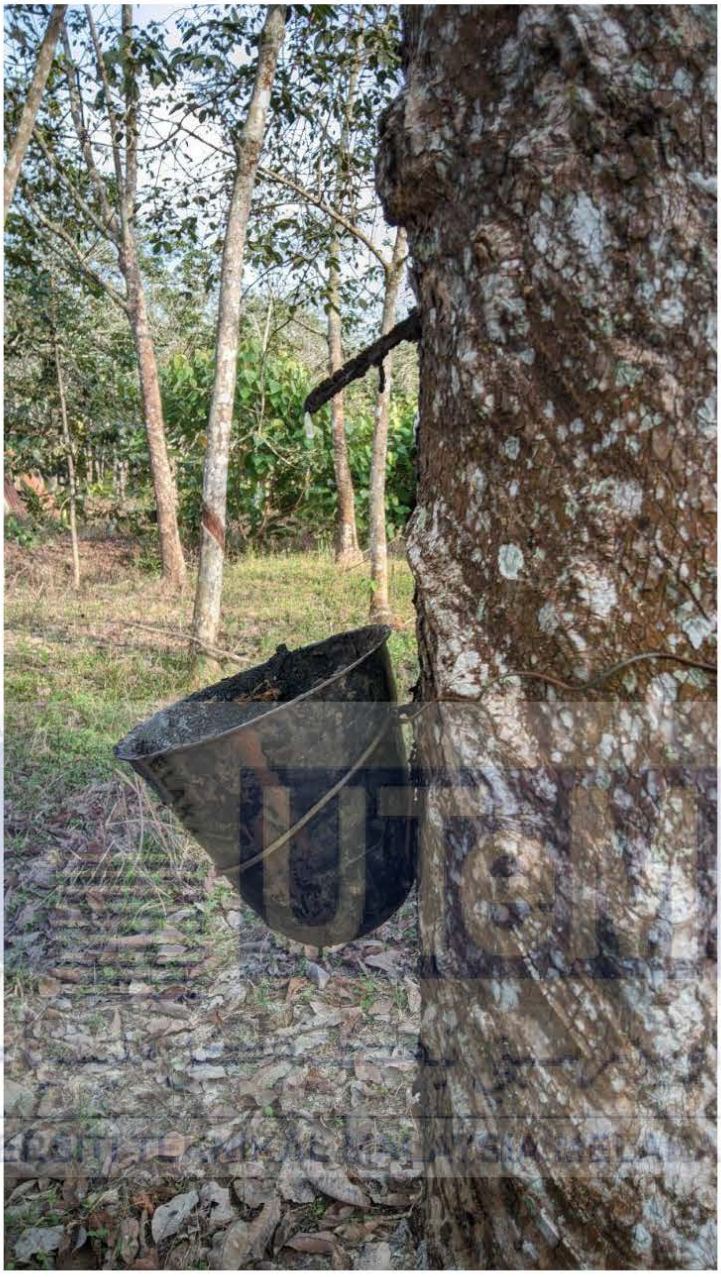
4. Infrastructure

   - Does information related to infrastructure in the rubber industry available and easily accessible? Explain

5. Quality

   - What factors contribute to the increase in quality rubber production?
   - What factors cause poor quality rubber production?
   - Do water quality a factor affecting the production of quality rubber?

APPENDIX 4 - THE INTERVIEW OF FARMERS



Gantt Chart for PSM 1

Procedure for PSM 1	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Activities															
PSM Briefing session															
Topic and supervisor search and confirmation															
First meeting with Supervisor															
Modify research topic															
Briefing on the content of chapter 1															
Introduction															
Write up Chap 1															
Completion of Chap 1															
Briefing on the content of chapter 2															
Discussion on the scope of research															
Literature Review (LR)															
Write up Chap 2															
Completion of Chap 2															
Briefing on the content of chapter 3															
Research Method															
Write up Chap 3															
Completion of Chap 2															
Submission of FYP 1															
Presentation of FYP 1															

Gantt Chart for PSM 2

Procedure for PSM 2	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Activities															
PSM Briefing session															
Meeting with PSM Supervisor															
Interview questions development															
Meeting with PSM Supervisor															
Modify interview Questions															
Data collection															
Completion of chapter 4															
Completion of chapter 5															
Presentation of PSM 2															
Final correction for Thesis															
Submission of PSM 2															