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SALCRA: ITS CONTRIBUTIONS TO THE SOCIO-ECONOMIC DEVELOPMENT OF SARAWAK RURAL AREAS

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ABSTRACT

Sarawak Land Consolidation and Rehabilitation Authority (SALCRA) is currently managing 19 oil palm estates for participants and five oil palm mills. These oil palm plantations and oil mills employ thousands of workers both professional and handymen/women. Our findings indicate that the oil palm industry has enhanced people's economic well-being and has ensured that unutilised land is economically viable as a result of oil palm cultivation. At the same time, it is logical to argue that the oil palm plantations and oil mills have economically empowered many communities that are housing them directly and indirectly. Data from the field indicates that people around oil palm fields and those involved in the cultivation process show pictures of benevolent plants. Working within the premises of the Sarawak state government, SALCRA works to create a well-balanced urban and rural development based on a holistic development benefit for the people of Sarawak, regardless of their place of residence and work. The oil palm has different meanings depending on the informants involved. Furthermore, the SALCRA management team has continued to promote and implement a systematic development plan for Native Customary Rights land (NCR land) on a commercial basis.

Keywords: development, economy, rural communities, SALCRA, social.

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INTRODUCTION

In 1980, Alex Yui-Huen Kwan wrote;

In most developing countries, past development efforts appear to have failed to bring about a real development breakthrough (especially in the rural areas) ... the recent spate of the world economic crisis associated with global inflation-cum-recession ... has hit many developing countries very hard, especially those in South Asia. In Malaysia, some even suggested that although money income has gone up, there are disquieting signs that the quality of life is deteriorating and that many people are finding it more and more difficult to satisfy their basic needs.

Outcomes of socio-economic debates often conclude that the most poverty occurs mostly in rural areas throughout the world. Hence, many government agencies and non-governmental agencies give high priority to rural development. Although the nature of the problem is changing, it will continue to change in the future. The contemporary rural reality challenges our traditional view on how to develop rural areas in a dozen different ways. According to Maxwell *et al.* (2001), there is no shortage of narratives about-or prescriptions for-rural development. Past narratives have included 'Community Development', 'The Green Revolution', and 'Integrated Rural Development'. Current narratives include a new, doubly green revolution, sustainable agriculture, rural livelihoods, and a growth-based, liberalisation-friendly narrative, which might be labelled the Washington Consensus on agriculture and rural development.

Today, Covid-19 and other factors have ensured the above 1980 assumption by Alex Yui-Huen Kwan

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is far from supposition, as many communities still question the role of SALCRA's efforts in rural community development and empowerment in Sarawak. Therefore, this article aims to critically assess and examine the roles and contributions of SALCRA as an institution established to economically empower and develop rural communities in Sarawak.

SALCRA, or the Department of Land Consolidation and Rehabilitation Authority in Sarawak, has been in operation for nearly 45 years since it started operation in 1976. In the early 1970s, SALCRA launched the Sarawak Land Development Commission's first Sarawak Land Development Programme (SLDB) with Skrang and Melugu rubber programs. Both regions are located in the Sri Aman province of Sarawak. Shortly thereafter, similar rubber plantation projects were established in Lambir Miri and later Sibu. These projects aimed to develop fallow lands while helping to create jobs and enhance the socio-economic well-being of the majority of people in these rural areas. One of the important goals of SALCRA then, and even now, is the restoration of land for agricultural purposes. The agency promotes and implements agricultural development or projects and plans in the State. These include, how to start and carry out projects, and plans to develop and improve agriculture individually or in collaboration with others in areas designated as development areas for agriculture.

With the oil palm plantation, the early activities, and chronology of the SALCRA's oil palm estates, the Lubok Antu oil palm project in Sri Aman was created in 1976 shortly after a test run in the same year. Since then, it has increased to 17 lands, including tea plantations covering more than 51 000 ha of land extending from Lundu to Bau, Serian, Sri Aman, Betong and Saratok. Since then, oil palm has been the most prominent crop favoured for large-scale land development under SALCRA's scheme.

LITERATURE REVIEW

Fold and Hansen (2006) traced the effects of the expanding oil palm cultivation in Sarawak. This study examines whether the experiences gained from about twenty years of oil palm cultivation and palm oil production on a global scale have been transferred to handle the particular technical, organisational, environmental, political and economic challenges in Sarawak. Similar to the objective of this research, it is to track down the socio-economic and political driving factors and effects of the oil palm expansionary process in Sarawak.

Besides, Rob and Patrick (2012), explored the characteristics of oil palm smallholders in Sarawak and the complex and varied processes by which

they have inserted themselves into the rapidly expanding landscape of large-scale plantation development. Their analysis shows the economic viability of independent oil palm smallholders and identifies appropriate means of support that could raise incomes and spread benefits more widely. Extensive landholdings derived from the traditional practice of shifting cultivation, continuing low population density, and the rapid growth of non-farm employment in the Malaysian economy have all combined to produce relatively land-abundant village agriculture. This is notwithstanding the ongoing internal land grab, as well as diversified livelihood portfolios in which non-farm sources of income and capital feature prominently. Predominantly, what we engage here is probably by looking at the situated condition played by SALCRA which elevated the life of rural areas population.

Sanggin and Mersat (2013) argued that a better understating of the current situation with the relevant authority will be able to solve some of the critical problems it is now facing. These writers noted that such an understanding will be useful to plan appropriate strategies for the successful project implementation of the existing ones and any other future project which involves the local community's participation. The authors further implied that there had been some significant changes in the lifestyle and quality of life of the Iban as well as the Bidayuh after the implementation of the oil palm plantation by SALCRA.

Sanggin and Mersat (2013) maintained, despite the decrease in the number of local people working in the oil palm scheme, SALCRA had brought some positive impacts to the Iban and Bidayuh indigenous communities in the form of infrastructural facilities, such as roads, water supply, electricity, clinics and so on, which make the overall quality of life of the local people generally better. Yet, it is vital to probe how far these positive impacts are taken or understood after several generations of SALCRA's participants in oil palm plantations.

METHODOLOGY

Immerse contribution and success of SALCRA have been widely discussed and witnessed by Sarawakians in general. Many authors have written good articles displaying how SALCRA has been transforming the livelihood and socio-economic of the participants and non-participants in general. Many even conducted thorough research, including gradual field works, interviews and a survey which consolidated both qualitative and quantitative modes of their research. As for this article, the qualitative method was used extensively. The conviction in the qualitative approach stems from the assertions of quality and verifiable data associated with this type

of method. Furthermore, the qualitative method prefers to collect data in natural settings as opposed to artificial and constructed contexts. Hence, the researchers obtained the data for this article mainly through empirical observation and in-depth interviews by extensively utilising unstructured open-ended questions.

Our mission was to make sure that our presentation and description of the establishment were as exact as possible. One that is verifiable in both explanatory and exploratory contexts. With this in mind, the researchers carefully selected participants or informants for this project. First, we made certain that our sampling matched the population it was intended to represent. To accomplish the aforementioned goals, the population obtains an unbiased sampling frame and selects a sample using purposive sampling techniques. The important thing to remember is that the characteristics of the majority of selected samples are similar to the totality of the research population.

The qualitative methods and the sampling technique used were to gain an empirical understanding of the underlying reasons, opinions, and motivations concerning SALCRA's rural development activities in Sarawak. In essence, the methods provided insights into the problem or fundamental issues within the study areas and SALCRA as a catalyst for rural development. Qualitative methods in the study were used to uncover trends in thought and opinions and dive deeper into the problem. To achieve this, a specific target group was concretised from the research proposal. Accordingly, the characteristics of the target group or the research population are designated as follows; people well versed in the activities of SALCRA, community members in Sarawak that housed SALCRA's project, people that are 19 years and above, participants in SALCRA oil plantations and more importantly knowledgeable individuals with accurate data on communal participation in bottom-up development.

As a result, the key informants were chosen because they are directly involved with SALCRA oil palm plantations. Direct involvement mainly refers to community members that participate in the SALCRA schemes. While indirect involvement refers to those who do not participate in SALCRA schemes. However, they are touched by SALCRA activities in some ways. For instance, some of them utilised infrastructures built by SALCRA and a number of them have either children or siblings gainfully employed by the organisation (SALCRA). Interview sessions were one-on-one. They were interviewed about the situation in their areas before and after SALCRA was established. The interviews were vital as it was the obvious way to listen to their stories on how they perceived

SALCRA's roles in their communities. The stories provide lives legibility when shaped as narratives. The importance of fieldwork has been highlighted in three areas:

1. What does SALCRA do as an organisation from the community perspective?
2. How does the community perceive SALCRA?
3. Why is SALCRA so prevalent in rural communities?

These questions will never be prudently answered unless an empirical process is charted. Thus, the researchers employed qualitative methods to document narratives and accounts that could not or would not be presented with a questionnaire. This is obvious as numerous key players within the oil palm industry in Sarawak are assorted and scattered inside and exterior of the state. Making it close conceivable to be arbitrarily chosen.

Our first objective was to gather essential data and look at what are the commitments of the institution, SALCRA to Sarawak's provincial change, particularly to the people's common well-being. The essential information drops into two categories. To begin with, our in-depth interviews and our empirical perception. On numerous occasions, 'being there is everything'. By being there, we watched and accumulate rich precision data. In this way, we specifically connected with individuals, their inclusion, values, convictions, and feelings concerning the exercises of SALCRA in their communities. The perception manoeuvres our understanding of exercises built by SALCRA and others that happens as well impacts of ventures.

In addition, secondary data were employed. The secondary data from different sources made it conceivable to analyse the past rustic advancement approaches and assess them in connection to the rise and advancement of SALCRA. The secondary data incorporates data from the SALCRA Headquarter, together with the data we gathered from the SALCRA districts offices such as the Serian and the Saratok. The data collection involved numerous stakeholders which we categorised as follows:

- Group 1 - Top Management of SALCRA (1 informant chosen)
- Group 2 - SALCRA Land Development Committee Members (AJPLS) (6 informants chosen)
- Group 3 - SALCRA Pioneer Staff (3 informants chosen)
- Group 4 - Community members Participants (16 informants chosen) and non-Participants (11 informants chosen)

Though, initially, no sample size was pre-determined. The initial goal was to collect as much quality data as possible. The researchers decided

that the saturation point determines the actual sample size. Appropriate respondents are those who meet all the criteria identified in the research informants criteria. In sum, 37 respondents or informants were interviewed for this article. This is beside members of the focus groups in Saratok and Mongkos.

Data for this article were obtained from two out of the four regions in which SALCRA oil palm estates are currently located. These are Serian Region and Saratok - Saribas Region. Data were gathered from respondents in the following areas Mongkos and Bugu in the Serian region and Saratok and Lubok Antu in Saratok - Saribas Region. The choice of these four areas was based on the detailed and quality data gathered from them. Also, the operational period of SALCRA activities in these four selected areas was considered. More importantly, researchers were able to carry out focus group interviews in Saratok and Mongkos during the data collection. The data from these four kampongs/areas are precise and verifiable.

RESULTS AND DISCUSSION

Data from the field, speak volumes of SALCRA development activities in Sarawak rural communities. SALCRA's development drive in Sarawak is designed in various stages and through several paths. Communities' benefit varies, the same as individual opinions. While many acknowledged the great contribution of SALCRA towards their community development, few have a negative overview. This is to be expected, views and perceptions differ, depending on individual or group understanding of what is needed or desired by specific groups.

Based on the data, most informants, especially the first generation that offered their lands to be developed by SALCRA, are full of praise for the work the agency has done in their communities. For instance, one informant from a village in Lundu which is a town, in a district located in the northwest of the Kuching Division of Sarawak;

"Before SALCRA started the oil palm in our land, it took two to three days to reach the major cities or even Kuching. There was no road, no car and we merely depended on long tracking and boat to move about".

One Ketua kampung opines;

"What is the use of having land and you don't have the resources to put it into use ... are you going to eat the forest?"

Data from this group of first-generation participants in the SALCRA project, are very revealing and tell of the joyous relationship

between the agency and the community members. According to this group, the initial encounter with SALCRA officials in the 1970s was apprehensive, because the agency's proposal was too good to be true. They argued, *"Their experience with government officials then were not characterised by civil, respect and understanding"*.

From their explanation, an early encounter with the State's agencies and officials was very bureaucratic, devoid of respect, and had a top-down approach. They maintained SALCRA officials were 'human like us'. The data shows there was mutual respect and community engagement was a major tool in building rapport and trust between SALCRA and the community members. One respondent from Bau, a gold mining town and a district in the Kuching Division of Sarawak, said;

"...When SALCRA officials visited our Kampung, they were very open, and they explained everything in the language we understood, that is why we believed and trusted them. They did not fail us, today I am proud to be among the first people in our kampung to have joined their project...but there are still many people in my kampung who don't then...now they are full of regret".

These groups that supported the activities and projects of SALCRA had listed the following benefits they derive from the agency. These include:

- i. Issuance of land titles;
- ii. Payment of dividend;
- iii. Opportunities for employment;
- iv. Entrepreneurship;
- v. Provision of infrastructures; and
- vi. Locals' involvement in management.

About 95% of our informants (this includes members of our focus groups) that are participants in SALCRA project, strongly acknowledged these benefits. However, not all agreed on the degree of the benefits. For instance, some argued the 'issuance of land titles' is very slow and only benefits a few. Others took issue with the payment of dividends. Some argued it is not standardised and in some years, lesser amounts are paid. Indeed, the majority of non-participants in the SALCRA's project cling to these factors and drive home their point that the agency only benefits the state and not the community. It is hard to write off their argument, yet as a researcher, it is vital to critically analyse the data objectively devoid of emotion or sentiment. Thus, our data noted that the issuance of land titles is slow and sometimes it benefits recent applications as against earlier ones. Of course, to get to the root of the matter, we interviewed SALCRA staff. They did not in any way deny it, but explained to our research team;

"...We treat every application the same, professionally, urgently, and diligently. Unfortunately, the final decision is not by us and that decision is with Sarawak Land Survey, we cannot push them to move fast, nor can we decide for them whom is entitled or not. But we always do our very best for all our project participants".

On the dividends, the SALCRA officials explained the decision to pay high or low dividends purely depends on the international market, production level, labour and other unknown circumstances. But *"we always ensure participants received their dividends twice a year"*.

Most of our respondents or informants acknowledged this fact. According to some, the month of June and February yearly is celebrated as the months of 'Bonus'. 'We usually make our economic plans around these two months'. Several respondents maintained these financial gains go a long way toward solving lots of family problems, such as children's bills, clearing lands for farming, or building new houses. It is equally important to understand, the amount received from SALCRA by an individual landowner depends on how many hectares the agency is cultivating. What is more, these lands are solely owned by the participants. As one SALCRA official stated:

"The approach adopted by SALCRA in its land development programme is on in-situ type of development, i.e., bringing projects to where there are already people instead of bringing people to project. Land development under SALCRA's concept makes use of the existing unutilised or underutilised lands for the benefit of landowners or claimants without jeopardising their rights of ownership or claim to such land. Implementation of projects is modelled in such a way that SALCRA will provide the funds, expertise, and management, while the landowners or participants are to provide land and labour".

Additionally, the data from the field showed, SALCRA's involvement with the rural communities ushered in other forms of development. These include infrastructures, clean water, rural electrification, jobs, investments, scholarships, etc. These developments our informants claimed; 'they wouldn't be possible if SALCRA did not step into their lands and communities'. We equally observed that in some of the villages, community members have taken advantage of SALCRA plantations to open sundry shops to cater to the agency's workers. The data also indicated that some community members are often contracted by SALCRA to offer certain works in the plantations and estates.

Interestingly from all the interviews conducted throughout the fieldwork, researchers were able to

identify three obvious groups. These groups were never mentioned in any other research or writings on SALCRA. These are the first-generation, second-generation, and third-generation. Indeed, most first-generation are comfortable saying; 'SALCRA means to our people and communities in Sarawak as light and hopes because - 'Promise made; the promise fulfilled'. The second and third generations have slightly different opinions. This is understandable as these two generations failed to acknowledge the history of Sarawak in making their conclusions.

According to Boyfield (2015), Sarawak experienced political instability during the first decade of joining the Federation of Malaysia. The old way of life adhered to by the nomads of the deep forest became increasingly unstable. The introduction of modern medicine has exacerbated the problem as humans have been able to survive previously deadly diseases such as cholera and diphtheria. A rapidly growing population is struggling to find work. Many were unable to do this and as a result, fell into extreme poverty. Being said this, from the interviews, similar stories and confessions of the hardship were uttered emotionally. This was seen especially most from the first-generation respondents and getting lesser and lesser similar views shared with the second and third generations. We now understand how a corporation named SALCRA has changed their well-being drastically. Sarawak has been ambitious in investing in the plantation economy. This created important employment opportunities and improved the standard of living of locals. In addition, large trading companies work with smallholders in product processing and marketing. The Sarawak Government has always emphasised balanced urban and rural development to achieve overall development that benefits both urban and rural populations.

CONCLUSION

According to one of the earliest SALCRA staff, Maxanthony SALCRA's main objective was to uplift the socio-economy well-being of the rural communities, and that is the main objective if we go back to history, especially after the formation of Malaysia. One of the main challenges of government at that time, especially among the rural communities was poverty eradication. In rural communities the available asset was land so, it is only natural and logical that rural poverty eradication was land-based. So that is how SALCRA was formed.

The statement above summed up the fundamental goal of SALCRA formation. Data from the field justifies it. Indeed, from the top

management to support staff, many identify SALCRA as a big provider for rural socio-economic wellbeing. Sounded big by its sound, the top-down plantation-village type model witnessed how SALCRA was able to transform a traditional sector into joint venture oil palm schemes. This is a huge opportunity not only for the communities in Sarawak but for the image of the State as well. As in Peninsular Malaysia and Sabah, they are proud of their FELDA, and Sarawak too with their SALCRA. Nevertheless, SALCRA, main objective as a catalyst for addressing the overall well-being of the rural communities is through the development of their lands. Thus, by converting unproductive community lands into productive and far later becoming commercial agricultural land. This comes with accessibility and massive rural development. From the SALCRA perspective, this is an opportunity to eradicate poverty.

One of the government's most effective strategies to date has been a large and systematic land with commercial indigenous customs rights or NCR land implemented by the Sarawak Land Consolidation and Rehabilitation Department (SALCRA). The main purpose of SALCRA is to improve the general well-being of rural communities by developing land for plantation agriculture. Over the last three decades, the success of this programme, which turns fallow indigenous land into productive farmland, has led to greater rural development, poverty eradication and job creation, which has improved the standard of living of locals in the region. It has helped to make it, improve rural areas. SALCRA was able to achieve such development with rural communities because the agency holds steady to the community participatory approach or the bottom-up approach.

A contrast with certain statements claimed that these rural areas disintegrate when they are incorporated into the market economy and political structure of Sarawak. However, the actual data are completely inconsistent with the above statements as SALCRA as Sarawak's government or agency is gradually integrating local Sarawak into the market economy. In essence, it institutionalised cash crops as a means and process to promote rural economies. As is often said, beauty is in the eyes of the beholder. Oil palm has different meanings depending on the person. Data from people around palm oil fields and cultivation show pictures of benevolent plants. It makes a lot of capital for people and is very efficient at making capital from limited land. The Sarawak Government founded SALCRA in 1976 based on this understanding is to promote the rural development of the community and the economic affluence of the community. This understanding was supported by most respondents over the age of 55 years who were interviewed. This group of informants was the first-generation landowners and participants

of the SALCRA project. This group's conclusion is obvious, as the saying goes, 'who feels, knows it'. They experienced political instability during the first decade of joining the Federation of Malaysia, so they are in a better position to make a judicious conclusion.

It can be said pragmatically that the success of the palm oil industry in Sarawak is built on the favourable endowment of natural and human resources. Without such incentives, the relationship between SALCRA and the community will hardly be sustainable.

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TECHNICAL EFFICIENCY OF OIL PALM PLASMA SMALLHOLDERS IN INDONESIA

IRAWATI ABDUL¹; DYAH WULAN SARI^{2*}; TRI HARYANTO² and THINZAR WIN³

ABSTRACT

This study examines the technical efficiency and influencing factors of oil palm production by plasma smallholders in Indonesia. The common method of analysis for this type of study is the stochastic frontier method based on the translog production function. The agricultural business household income survey (2013) of the Central Statistics Agency was used as a secondary data source where there were 2438 oil palm plasma smallholders registered in the Indonesian oil palm sector. The study found that the average value of technical efficiency of these plasma smallholders is 0.59 which means that there is room for improvements to increase it further. East Kalimantan has the highest efficiency value, compared to other provinces. Moreover, education and association memberships of smallholders, and seed quality had positive effects but the effect is negative with age of the smallholders in the oil palm sector in Indonesia. The distribution of technical efficiency level of farmers showed that only 0.94% of plasma farmers were efficient in their production. The Indonesian government should emphasize training programmes for plasma farmers to improve their efficiency in production

Keywords: Indonesia, palm oil, plasma farmer, technical efficiency.

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INTRODUCTION

Oil palm (*Elaeis guineensis*) is one of the strategic commodities in Indonesia. In 1982, the total oil palm plantation area was 294 560 ha and has increased to 14 326 350 ha as of 2018 (BPS, 2018). This rapid development has resulted in Indonesia becoming the world's largest palm oil-producing country since 2006. The existing potential will have a multiplier effect for increasing income for the community, increasing the government's income, reducing poverty and improving natural resources. The bright prospect of palm oil in the world vegetable oils trade has encouraged the Indonesian

government to spur the development of its oil palm industry (Bachtiar, 2010).

In Indonesia, there are three main sectors in the oil palm industry. They are state companies, private companies and smallholders. In 2018, smallholder farmers owned 40.61% of the total oil palm plantation area with a productivity of 3.37 t/ha (BPS, 2018). It also creates job opportunities for nearly 2.6 million smallholders. The state companies and private companies planted 9.5% and 49.89% of total oil palm areas with a productivity of 4.06 and 4.62 respectively (BPS, 2018). Among the three main sectors, the productivity of the smallholder sector is the lowest. It means that the smallholder sector produces its products below their best potential.

The smallholder sector can be categorised into independent farmers (80%) and plasma farmers (20%). The independent farmers manage their plantation schemes themselves independently. The plasma farmers associated themselves with large companies through plasma-nucleus schemes. In the development of the oil palm industry, a plasma nucleus scheme is an important program. The plasma nucleus scheme is the partnership program between

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smallholders and companies in which the latter organises the development of palm oil production. In this program, the smallholders provide land and labour while the companies support production facilities, technical guidance and management as well as the market for the products (Euler *et al.*, 2016).

The low productivity of oil palm smallholders is alleged because the allocation of input usage is not optimal. Their managerial capability in managing and allocating production inputs will influence technical efficiency. Smallholders who, in their cultivation techniques, can manage the use of production factors to achieve maximum production yields can be said to be efficient (Varina *et al.*, 2020). Due to this, it is necessary to investigate the factors that influence production and technical efficiency in the smallholder sector. Therefore, technical efficiency and its determinants are still needed to be analysed for this sector.

Many studies explored the technical efficiency and productivity of oil palm production in Indonesia. Rahman *et al.* (2017) studied the effect of economic variables on the implementation of business diversification of household oil palm plasma smallholders. Ngadi (2019) analysed the income inequality of plasma farmers. Many studies focused on smallholder farmers and private companies. To our knowledge, the analysis of the technical efficiency of plasma farmers in Indonesia is still limited. This study aims to fill this gap to analyse the technical efficiency and its determinants for oil palm production by the plasma smallholders, comparing the technical efficiency at the provincial level and the individual farmer's level in palm oil production in Indonesia.

LITERATURE REVIEW

Hasnah *et al.* (2004) analysed the technical efficiency of NES-Trans oil palm plantations in West Sumatra using a stochastic frontier approach. Results showed that the average technical efficiency of NES-Trans farmers with the translog model is 0.66. It was found that the increase in outputs that occurred was due to better counselling and did not have to increase the number of inputs in production.

Iwala *et al.* (2006) analysed technical efficiency using the stochastic frontier in the oil palm region of Nigeria. The results concluded that the level of technical efficiency varies between oil palm farmers, ranging from 0.463 to 0.999. In addition, research results show that the age of oil palm trees, the cost of fertilisers and chemicals, and the cost of harvesting and managing have a positive correlation with production. On the other hand, the use of labour had a negative contribution to oil palm production because of the large number

of workers used. Similarly, the level of education of farmers also contributed negatively to efficiency level.

Lim *et al.* (2011) analysed the efficiency of 230 rice farmers in Malaysia with variables of farm size, use of fertilisers and the number of workers. The results showed that the efficiency value was 0.85 with an indication of all inputs used in optimum conditions.

Nordin *et al.* (2017) analysed the technical efficiency of independent oil palm smallholders in Sabah and Sarawak Malaysia. This study used technical efficiency analysis with a stochastic frontier approach and, the results showed that only 4.5% of oil palm smallholders were above the efficiency score of 0.9. The technical inefficiency here was caused by the inadequate application of fertilisers, *Ganoderma* disease, pest attacks, nutrient factors in oil palm soil, high production costs and erratic weather factors.

Mustapha (2011) analysed the agricultural efficiency of rubber smallholders in Besut, Terengganu, Malaysia. The analysis used the output (y) as a dependent variable. The cultivated land per hectare (x_1) and the intensity of land use per day (x_2) are used as independent variables. The results showed that rubber farmers' plantations are at a score of 0.95 to 1.00 the value of the Technical Efficiency score.

Furthermore, Tijani *et al.* (2017) analysed technical efficiency across various age groups of oil palm in Johor, Malaysia. Crop age categories are classified as under 9 years crop age, 9-18 year crop age and 19 years and above crop age. The study revealed that 19 years and above crop age have the highest efficiency. All the crop age categories have a constant return to scale in the study area. The results of the analysis found that household extension factors, farmer age, access to credit, soil conservation, household income, experience, education level, farmer group membership and government intervention were the determining factors for technical efficiency.

Puruhito *et al.* (2019) studied the technical efficiency and influencing factors of oil palm in West Sulawesi. The level of technical efficiency is positively related to the land area, the use of the family member, the use of NPK fertiliser, the age of the oil palm trees and the distance of the estate to the river. The age of the farmer and the difference in plasma pattern have a positive effect on the inefficiency of oil palm plantations.

Ismiasih (2017) analysed the technical efficiency and influencing factors of palm oil production in West Kalimantan Province. This study used the Cobb-Douglas production function. The result showed that the value of average technical efficiency is 0.83 and the age of the farmers, education level of farmers, counselling participation, and membership

of farmers' unions and cooperatives are significant factors for increasing technical efficiency. Ibitoye *et al.* (2011) analysed the influencing factors on the production of oil palm in Ondo State, Nigeria. The regression analysis result showed that the level of education and the number of training for oil palm farmers are significant for oil palm production.

METHODOLOGY

This study was conducted to analyse the technical efficiency of Indonesian oil palm plasma smallholders in Indonesia. In this regard, technical efficiency is obtained from the ratio of an output produced by a smallholder to the output when he/she is fully efficient. Fully efficient means that all inputs are processed optimally without any wasted residuals.

Fried *et al.* (2008) explained that technical efficiency is the ability to produce as much output as possible from certain inputs or by producing output with technology and the use of as few inputs as possible. In calculating technical efficiency, there are two models, namely parametric and nonparametric models. However, the nonparametric model has limitations. The nonparametric method did not take into account statistical noise. Therefore, this study used a parametric model, mentioned by Coelli *et al.* (2005) as Stochastic Frontier Analysis (SFA) which has accommodated the calculation of errors caused by statistical noise and the effects of technical inefficiency.

The stochastic frontier model was introduced by Aigner *et al.* (1977) and Meeusen and Broeck (1977). The stochastic production function developed by Battese and Coelli (1992), Battese and Coelli (1995) and Coelli *et al.* (2005) can be expressed as follows;

$$Y_i = X_i\beta + V_i - U_i \quad (1)$$

where Y_i is the production of the i -th firm; X_i is the vector of inputs quantities of the i -th firm; β is a vector of unknown parameters; V_i is random variables and U_i is the inefficiency term. Equation (1) can be rewritten in regression form as Equation (2).

$$\ln y_i = \beta_0 + \sum_M \beta_m \ln x_{mi} + \varepsilon_i \quad (2)$$

where, y_i is the output, x_i is the farm, m is the input used in the oil palm production, β is the coefficient and ε_i is the error term.

Following Coelli *et al.* (2005), the technical efficiency of oil palm production by plasma farmers can be estimated with Equation (3);

$$TE_i = \frac{y_i}{y_i^*} = \frac{\exp(x_i\beta + v_i - u_i)}{(\exp(x_i\beta + v_i))} = \exp(-u_i) \quad (3)$$

TE is the technical efficiency, y_i is the observed output, y_i^* is the maximum output and u_i is the value of technical efficiency. The value of technical efficiency (TE) is between zero and one ($0 \leq TE_i \leq 1$). When $TE = 1$, it indicates a firm is fully efficient, otherwise fully inefficient.

The empirical model used in this study is a translog production model and this model is analysed by using the software Frontier 4.1. The translog production model used in this study can be written as Equation (4);

$$\begin{aligned} \ln y_i = & \beta_0 + \beta_{Po} \ln Po_i + \beta_{Pu} \ln Pu_i + \beta_{Ps} \ln Ps_i + \\ & \beta_{Tk} \ln Tk_i + \beta_{La} \ln La_i + 0.5\beta_{Po} (\ln Po_i)^2 + \\ & 0.5\beta_{Pu} (\ln Pu_i)^2 + 0.5\beta_{Ps} (\ln Ps_i)^2 + 0.5\beta_{Tk} (\ln Tk_i)^2 + 0.5\beta_{La} (\ln La_i)^2 + \beta_{Po} \beta_{Pu} \ln Po_i \\ & \ln Pu_i + \beta_{Po} \beta_{Ps} \ln Po_i \ln Ps_i + \beta_{Po} \beta_{Tk} \ln Po_i \\ & \ln Tk_i + \beta_{Po} \beta_{La} \ln Po_i \ln La_i + \beta_{Pu} \beta_{Ps} \ln Pu_i \\ & \ln Ps_i + \beta_{Pu} \beta_{Tk} \ln Pu_i \ln Tk_i + \beta_{Pu} \beta_{La} \ln Pu_i \\ & \ln La_i + \beta_{Ps} \beta_{Tk} \ln Ps_i \ln Tk_i + \beta_{Ps} \beta_{La} \ln Ps_i \\ & \ln La_i + \beta_{Tk} \beta_{La} \ln Tk_i \ln La_i + v_i + u_i \end{aligned} \quad (4)$$

where, y_i is the output of oil palm plantations on the i -th plantation. Po (number of trees in the whole farm), Pu (fertiliser), Ps (pesticide), Tk (labour) and La (land) are the inputs used in the production process. β_s represent the estimated coefficient. v_i is the random error and u_i represents technical efficiency. The influencing factors of technical efficiency can be estimated by Equation (5).

$$u_i = \delta_0 + \delta_1 X_{1i} + \delta_2 X_{2i} + \delta_3 X_{3i} + \delta_4 X_{4i} + \varepsilon_i \quad (5)$$

where, X_{1i} is the level of education of the farmers on the i -th plantation, while X_{2i} , X_{3i} and X_{4i} are the age of the farmers, quality of seeds and the membership of farmers association respectively.

The value of technical efficiency and all other influencing parameters as stated in Equations (4) and (5) are simultaneously estimated by using Software Frontier 4.1. After running the data, we calculated the average technical efficiency value of each province by combining the value of the technical efficiency of the province.

DATA AND VARIABLES

The data in this study are taken from the official secondary data released by the Central Bureau of Statistics (BPS) in Indonesia through the Agriculture

Survey (Agriculture Household Income Survey) data for Indonesia in 2013. The data represent the total number of 2438 plasma smallholders in the oil palm plantation in Indonesia. Palm oil output (y) includes all the value of the primary product, the value of by-products, the value of self-harvested production and the value of slash. The number of trees is adjusted by the weighted tree (K) (Alwarritzi *et al.*, 2015; Hasnah *et al.*, 2004; Varina *et al.*, 2020). The weighted trees can be calculated by using either the non-linear least square regression method or the age-yield profiles method from the literature (Hasnah *et al.*, 2004). This study follows the second method, *i.e.* age-yield profile. The weighted trees can be defined as Equation (6):

$$K_i = c_1 K_{1i} + c_2 K_{2i} + c_3 K_{3i} \quad (6)$$

where K_i is the number of weighted trees on farmer i . K_1 , K_2 , K_3 are the age categories of 3-7 years, 8-16 years and above 16 years respectively. c_1 , c_2 and c_3 are the weight of each age category. By following Varina *et al.* (2020), the value of c_1 , c_2 and c_3 are 0.81, 1.00 and 0.98 respectively.

Fertilisers (Pu) include several types of fertilisers, namely Urea, TSP/SP36, ZA, KCL, NPK, organic fertilisers (manure/compost) and other fertilisers. Pesticides (Ps) include solid and liquid pesticides which are used in the production of palm oil. Labour (Tk) is the number of employees in oil palm plantations. Land area (La) is calculated by multiplying the number of trees with the spacing between trees. The education (X_{1i}) is based on the education level of the farmers and is measured by the number of years of schooling. Age (X_{2i}) is the age of smallholders. Seed quality (X_{3i}) is classified as uncertified seed (0) and certified seed (1). Member

of farmers association (X_{4i}) is marked as one (1) if farmers are a member of farmers association and zero (0) for otherwise.

RESULTS AND DISCUSSION

Table 1 shows the summary statistics of palm oil production.

Table 1 shows that the plasma smallholders of oil palm in Indonesia can produce an average output of USD7333.34 with a standard deviation of USD10 177.45 and the minimum and maximum output values are USD5.16 and USD193 858.47 respectively. The average number of trees is 412 with a standard deviation value of 574.09 and minimum value is 16 and a maximum value is 12 658. The plasma farmers used the average fertilisers and pesticides of USD874.64 and USD116.08 respectively with a standard deviation of USD1778.92 and USD207.60. The mean value of labour is four persons and the standard deviation is 3.37. The minimum use of labour is one person and the highest labour is 96 persons. The average years of education are equal to 2.50 years with a standard deviation value of 1.76 and the lowest level of education is 0 (no formal education) and the highest level is 14 years (postgraduate). The average age of farmers is 47 years old and the minimum and maximum age levels are 18 years old and 99 years old respectively. Seed quality and members of farmers' associations are defined as dummy variables.

Table 2 shows the results of the maximum likelihood estimation of oil palm production and factors influencing the technical efficiency of oil palm production. In the inefficiency model, the negative sign of a variable shows a decrease in inefficiency (an increase in efficiency) and the positive sign shows an increase in inefficiency (a

TABLE 1. SUMMARY STATISTICS

Variable	Unit	Obs	Mean	Std. dev.	Min	Max
y (output)	US dollar	2438	7 333.34	10 177.45	5.160	193 858.47
Po (tree)	Number of weighted trees	2438	412.00	574.09	16.000	12 658.00
Pu (fertiliser)	US dollar	2438	874.64	1 778.92	3.150	45 348.35
Ps (pesticide)	US dollar	2438	116.08	207.60	0.190	4 588.36
Tk (labour)	Number of people	2438	4.00	3.37	1.000	96.00
La (land)	Hectares	2438	4.58	48.87	0.002	2 160.00
X_1 (education)	Years of schooling	2438	2.50	1.76	0.000	14.00
X_2 (age)	Years	2438	47.00	10.73	18.000	99.00
X_3 (seed quality)	Dummy	2438	0.84	0.35	0.000	1.00
X_4 (member of farmers association)	Dummy	2438	0.05	0.23	0.000	1.00

Source: BPS.

decrease in efficiency) (Battese and Coelli, 1995). Education is found to positively influence oil palm production at a 5% significant level. The result shows that the higher the level of education, the higher the level of technical efficiency. If the education level of farmers increases by one year, the technical efficiency increase by 0.39. This is because the farmers with a higher level of education can learn easily about any matters concerning advanced technology and can find new knowledge for improving technical efficiency. This result is opposite to the finding (Ismiasih, 2017). But this is consistent with the results of Fariani *et al.* (2018) in which education can increase technical efficiency. This is because education can be an important factor in shaping the mindset and decision-making process of undertaking the business (Emilia and Hutabarat, 2014). Meanwhile, the age of the farmer is found to have a significant negative influence on oil palm production at a 1% level. This means that younger farmers are higher in efficiency as compared to older farmers. If the farmers are younger, the technical efficiency can increase to 0.03. This is because the oil palm plantation activities require physical strength that better suits the younger farmers. This is consistent with the result of Ismiasih (2017) and Puruhito *et al.* (2019).

The quality of the seed is found to positively affects the level of efficiency at a 10% level of significance, meaning that certified seeds can increase the efficiency level of oil palm production. Using certified seeds can increase the technical efficiency by 1.70. This result is consistent with the study by Kariyasa (2015) which indicates that the use of certified seeds can increase the productivity of oil palm. The association membership of farmers also shows some significant effect on efficiency at a 5% level. If farmers are members of the farmers association, the value of technical efficiency increase to 6.25. This tells that farmers who are members of farmers' associations have better efficiency for their better access to knowledge on new methods, facilities and infrastructures.

Table 3 shows the output elasticity of each input variable such as the number of weighted trees (P_o), fertiliser (P_u), pesticide (P_s), labour (T_k) and land area (L_a). Output elasticity can be calculated by partially taking the first-order derivative of the selected translog model. Output elasticity means how much the percentage of output will rise when the use of input is increased by 1%. According to the results, the value of elasticity of all input variables is positive and inelastic. This means that the output will increase by less than 1% by increasing the number of inputs used by 1%. Among the inputs used in the production of palm oil, the highest average elasticity is the tree on palm oil output with a value of 0.73. This means that an increase in output produced by oil palm plantations can be caused by an increase

TABLE 2. MAXIMUM LIKELIHOOD ESTIMATION OF OIL PALM PRODUCTION

Variable	Coefficient	Estimated value	T ratio
Constant	β_0	2.99***	5.37
P_o	β_{po}	0.61***	3.26
P_u	β_{pu}	0.64***	5.17
P_s	β_{ps}	0.15	1.36
T_k	β_{tk}	0.42**	2.07
L_a	β_{la}	0.15*	1.97
P_o^2	β_{popo}	0.90	1.57
P_u^2	β_{pupu}	0.04**	2.16
P_s^2	β_{psps}	0.04***	2.82
T_k^2	β_{tktk}	0.02	0.55
L_a^2	β_{lala}	-0.01	-1.17
$P_o P_u$	β_{popu}	-0.06**	-2.47
$P_o P_s$	β_{pops}	0.03	1.11
$P_o T_k$	β_{potk}	-0.07	-1.55
$P_o L_a$	β_{polal}	0.01	0.56
$P_u P_s$	β_{pups}	-0.06***	-3.40
$P_u T_k$	β_{putk}	0.02	0.73
$P_u L_a$	β_{pula}	-0.02***	-2.71
$P_s T_k$	β_{psitk}	-0.02	-1.01
$P_s L_a$	β_{psila}	0.00	0.28
$T_k L_a$	β_{tkila}	0.03*	1.77
Inefficiency			
Constant	δ_0	-20.34***	-5.32
Education	δ_1	-0.39**	2.17
Age	δ_2	0.03***	3.80
Seed quality	δ_3	-1.70*	-1.85
Member of farmer association	δ_4	-6.25**	-2.08
Sigma Square	σ^2	0.11***	5.91
Gamma	γ'	0.98***	474.14
Log-likelihood function		-2239.84	
Error one-sided LR test		474.02	

Note: ***, ** and * are the significant level of 1%, 5% and 10% respectively.

TABLE 3. ESTIMATION RESULTS OF OUTPUT ELASTICITY CONCERNING EACH INPUT

Variable	Elasticity
Elasticity of tree (ϵ_{p_o})	0.73
Elasticity of fertiliser (ϵ_{p_u})	0.10
Elasticity of pesticide (ϵ_{p_s})	0.07
Elasticity of Labour (ϵ_{T_k})	0.04
Elasticity of land (ϵ_{L_a})	0.02
Total (ϵ)	0.98

Note: Total elasticity = $\epsilon_{p_o} + \epsilon_{p_u} + \epsilon_{p_s} + \epsilon_{T_k} + \epsilon_{L_a}$.

in the number of trees. The value of the elasticity of the fertiliser is 0.10, meaning that by increasing the spending of fertiliser by USD1, it can increase the output by 0.10 units. The value of the elasticity of pesticide (0.07), labour (0.04), and land (0.02) show that the value of each elasticity is too small to affect the output.

The mean value of technical efficiency for each province is shown in Table 4. The East Kalimantan has the highest efficiency score with an efficiency value of 0.72. The Jambi is the second largest and a value is 0.71 and the third one is the Riau with a value of 0.69. The provinces with the three lowest efficiencies are South Sulawesi, Central Sulawesi and Aceh with the value of 0.48, 0.47 and 0.33.

TABLE 4. MEAN VALUE OF TECHNICAL EFFICIENCY OF OIL PALM PRODUCTION

No.	Province	Technical efficiency
1	East Kalimantan	0.72
2	Jambi	0.71
3	Riau	0.69
4	West Sulawesi	0.68
5	North Sumatera	0.66
6	South Kalimantan	0.65
7	South Sumatera	0.65
8	West Sumatera	0.64
9	West Kalimantan	0.63
10	Central Kalimantan	0.63
11	Lampung	0.61
12	Bangkulu	0.55
13	Kepulauan bangka Belitung	0.51
14	Southeast Sulawesi	0.51
15	South Sulawesi	0.48
16	Central Sulawesi	0.47
17	Aceh	0.33
Average		0.59

Table 5 shows the distribution of technical efficiency levels of plasma smallholders. The value of technical efficiency is somewhere between 0 and 1. By following the works of previous researchers (Ariyanto *et al.*, 2020; Coelli *et al.*, 2005), smallholders can be technically efficient if their value of efficiency is greater than or equal to 0.9. If the value is between 0.7 to 0.9, the firm's technical efficiency level can be considered moderate. If the value is less than 0.7, the firm is technically inefficient. The result shows that more than 50% of the plasma farmers have moderate efficiency scores. In contrast, 45.98% of plasma farmers are not efficient in their production. Only 0.94% of

plasma farmers are regarded as efficient. Since the proportion of efficient plasma farmers is very low, the plasma farmers are recommended to extend their use of inputs to increase the efficiency level of their oil palm plantation.

TABLE 5. DISTRIBUTION OF THE LEVEL OF TECHNICAL EFFICIENCY

The value of technical efficiency	Number of plasma farmer	Percentage
TE < 0.7	1121	45.98
0.7 ≤ TE < 0.9	1294	53.08
TE ≥ 0.9	23	0.94
Total	2438	100.00

CONCLUSION

The average value of technical efficiency of oil palm plasma smallholders in Indonesia is found to be 0.59. This shows that there is room for improvements for these plasma smallholders to increase their efficiency level. The translog function suggests that the number of trees highly influences the technical efficiency and hence the production of palm oil by the plasma smallholders. In addition, other influencing factors include their level of education, age, their memberships with associations and seed quality. By increasing all these factors, plasma farmers can increase their efficiency level. The companies involved in the plasma-nucleus schemes should facilitate these plasma smallholders with training programs and knowledge-sharing sessions, thereby increasing the education level and technical efficiency of the farmers. The companies under the plasma-nucleus schemes also need to provide support to the plasma smallholders in using quality seeds while encouraging them to actively join farmers' associations.

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THE INTENTION TO ADOPT GREEN PESTICIDE AMONG OIL PALM PLANTERS: REVIEW OF THE EXTANT LITERATURE

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ABSTRACT

Pests and diseases can cause costly and irreparable harm to crops, especially oil palm. There are many methods that planters can adopt to manage them, and green pesticides can serve as an alternative solution. Preliminary research is carried out by adopting the theory of planned behaviour or TPB [attitude, subjective norms and perceived behavioural control (PBC)] for a sound conceptual framework. This paper, therefore, investigates the determinant factors affecting Malaysian oil palm planters to adopt green pesticides. A comprehensive literature review was used as the methodology. The Malaysian Sustainable Palm Oil (MSPO) was proposed as a moderator to optimise the planters' intention. Overall, 12 research propositions, recategorized in TPB, were discussed in this paper and identified as the factors affecting the oil palm planters' intention to adopt green pesticides. The proposition will lead to future empirical findings which are anticipated to facilitate the industrial transition toward utilizing environmentally-friendly pesticides.

Keywords: green pesticide, MSPO, oil palm planter, sustainability, TPB.

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INTRODUCTION

The Food and Agriculture Organization (FAO) of the United Nations (UN), has launched several guidelines for the 2030 Agenda for Sustainable Development including nurturing healthy ecosystems and supporting the sustainable management of land, water and natural resources while ensuring world food security (Food and Agriculture Organization, 2022). According to Malaysia's 12th National Plan, the country's ecosystems are continuing to deteriorate because of insufficient conservation efforts and a lack of appreciation for natural resources. The presence of several agencies enforcing diverse rules provides considerable challenges to natural resource management and the environment. Furthermore, governance challenges including limited enforcement capabilities, insufficient reporting and monitoring and R&D weaknesses.

In response to these efforts, the Malaysia's 12th National Plan produced a 2021-2025 strategic direction that includes new rules to be enacted, as well as amendments to relevant legislation such as Act 127, the Occupational Safety and Health Act of 1994, and the Poisons Act of 1952. The new laws require notification and reporting on the manufacturing, import, export, use and management of hazardous chemicals and substances.

As the biggest part of the agriculture sector in Malaysia, oil palm has become the major contributor to pesticide consumption. Oil palm estates are often encouraged to practice Integrated Pest Management (IPM) and Good Agricultural Practices (GAP). Regardless, no comprehensive IPM model was available within the field (Dara, 2019). As people create, promote, or employ IPM methods with various connotations, the definition is constantly modified and altered based on an individual's pest management goals and methods, and generalised across appropriate circumstances. GAP, on the other hand, encourages the employment of biological, cultural and mechanical approaches, but in emergency cases, pesticide application must be done less detrimentally to the environment (Bailey, 2014; Turan and Karaosmanoğlu, 2019).

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The UN FAO's annual report on import statistics of pesticide compounds demonstrates that these two essential agricultural practices have not yet succeeded significantly in reducing the use of synthetic pesticides. FOA UN recorded 4.2 million tonnes of pesticide use worldwide in 2019, as depicted in Figure 1 ("World Food and Agriculture – Statistical Yearbook 2021"), whereas Malaysia consumed about 47 805 tonnes as mentioned in Figure 2 (FAOSTAT, 2022).

Green pesticides remain a novel phenomenon among local commodity planters due to the heavy reliance on chemical pesticides as an affordable and effective pest eradication method (Dilipkumar *et al.*, 2020; Schreinemachers *et al.*, 2017; Terano *et al.*, 2015). As it turns out, green pesticide acceptance on a global scale pesticide is only 1% compared to its counterparts (Nnamonu and Onekutu, 2015; Walia *et al.*, 2017), and despite growing worldwide interest, commercial applications of green pesticides remain limited (Smith *et al.*, 2021). On the bibliometric analysis conducted in

2019, Scopus databases show that green pesticide research present a significant increase in the last three decades with studies mostly dominated by India, the United States and China (Sinha, 2012; Smith *et al.*, 2021) whilst Malaysia is still far to be included in the topics. Contributing to the global expansion in the use of green pesticides include the rising awareness of the harmful effects of synthetic pesticides on the environment (Kamaruzaman *et al.*, 2020; Komorowicz *et al.*, 2010; Zaidon *et al.*, 2018), the growing demand for a sustainable alternative (Adinew, 2014; Feng and Zhang, 2017; Kaur and Kaur, 2017; Koul *et al.*, 2008; Mossa, 2016; Sharma *et al.*, 2011; Singh and Singh, 2016), government laws on biodiversity conservation (Nan *et al.*, 2019), and the efforts of pressure groups (Haddi *et al.*, 2020).

Therefore, this research aimed to examine the factors influencing oil palm planters' intention to adopt green pesticides from current literature and present conceptual discussions for future investigation.

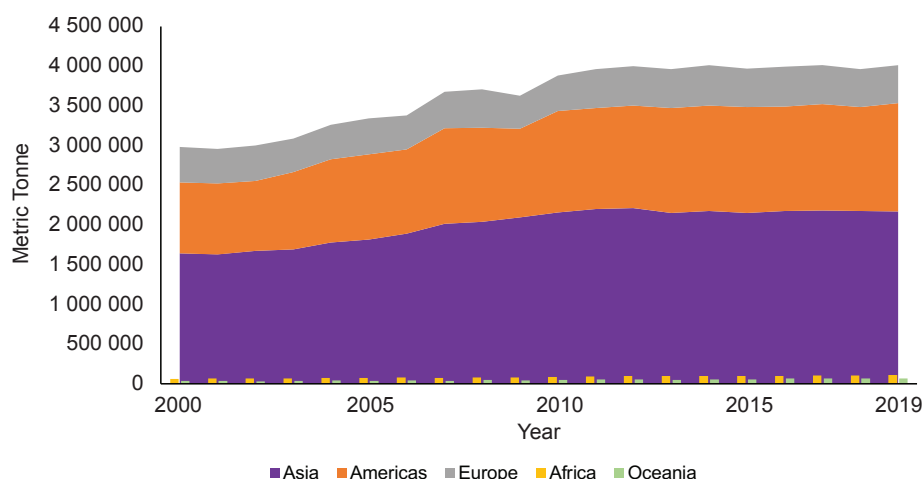


Figure 1. Global statistic of pesticide consumption.

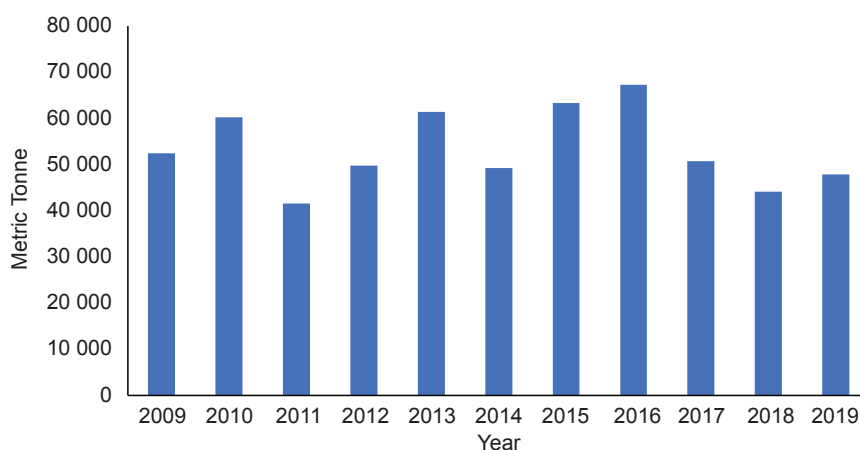


Figure 2. Malaysia's statistic of pesticide consumption.

LITERATURE REVIEW AS METHODOLOGY

The goal of a literature review is to examine, critique, and synthesise the literature on a specific study issue for new conceptual frameworks and perspectives to emerge. Semi-structured or integrative literature reviews enable researchers to create their standard and thorough strategy to guarantee that the suitability of the literature is adequately addressed to answer their research question while being transparent about the process (Snyder, 2019). Since the issue of green pesticides has not yet reached maturity in Malaysia, it is possible to examine the pertinent literature and use a well-known theory to conceptualise a new idea that can be implemented in the Malaysian oil palm context.

Theory of Planned Behaviour

Icek Ajzen's development of theory of planned behaviour (TPB) in 1985 remains a widely utilised scholarly reference worldwide. The predictive power of its theoretical validity has been demonstrated in multiple behavioural domains with over 2000 experiments (La Barbera and Ajzen, 2021). The immediate antecedent of behaviour in TPB involves the intention to execute desired actions. In this vein, intention essentially determines the initiation of action (Ajzen, 2015, Bosnjak *et al.*, 2020). The extent to which individuals possess real control over personal behaviour depends on the capacities to overcome such intricacies and the availability of enabling variables: Experience and external support. As the amount of existing behavioural control significantly affects the influence of intention on behaviour in line with TPB, high behaviour regulation abilities are associated with increased behaviour performance possibilities.

The TPB encompasses three determinant factors that affect intentions: Attitude (A) towards the behaviour, subjective norm (SN) concerning the behaviour and perceived behavioural control (PBC). A concrete intention to engage in action is only established when the perceived control over conduct is sufficiently strong despite the motivations from positive attitudes and subjective norms. Intention to participate in a certain behaviour denotes the proximal antecedent of voluntary action and could be appropriately described as a behavioural disposition or readiness to behave in a specific manner following a suitable condition (Ajzen and Dasgupta, 2015). The latest development of TPB in 2019 is represented by *Figure 3* showing that Attitude and Subjective Norm has a direct impact on the intention, while perceived behavioural control (PBC) is moderating both Attitude and Subjective Norm while affecting indirectly the actual behaviour.

Attitude

Perceivably, attitude towards action involves the easily accessible ideas of potential behavioural consequences or behavioural beliefs (La Barbera and Ajzen, 2021). A behavioural belief implies an individual's subjective likelihood, where participating in the desired action would result in specific outcomes or experiences. Meanwhile, attitude denotes a person's positive or negative emotions, thoughts, or assessment of a topic or object. In this regard, attitude is crucial in determining the engagement objectives in a particular behaviour that could change based on circumstances (Ajzen and Dasgupta, 2015; Imani *et al.*, 2020).

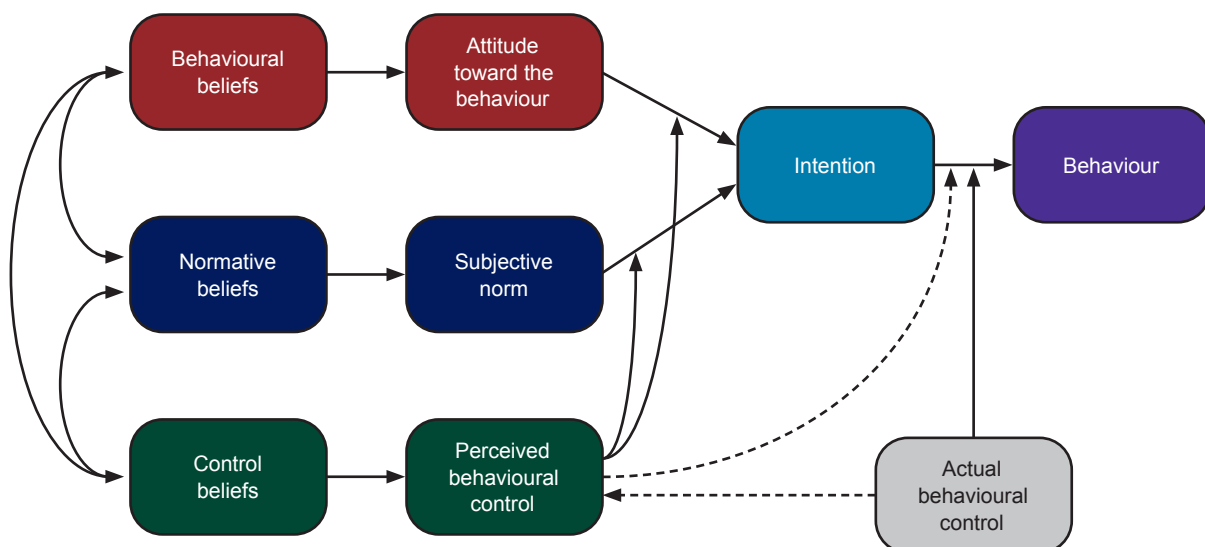


Figure 3. Schematic representation of TPB (Bosnjak *et al.*, 2020).

Knowledge denotes a frequently utilised study variable that facilitates purchase intention. From a business perspective, knowledge implies information about an entity, situation, or phenomenon that is studied or experienced by individuals. Notably, the essentiality and regrettable paucity of knowledge in decision-making processes have been examined in various studies (Haron *et al.*, 2005). Knowledge in environmental studies is defined as an individual's level of information involving environmental issues and their capacity to understand and evaluate social and environmental implications. For example, knowledgeable individuals directly affect the decision-making process, while people with insufficient information tend to disengage from sustainability behaviour (Haron *et al.*, 2005). Interestingly, Ajzen opined that knowledge does not directly influence the recent TPB development in terms of accurate information (Ajzen 2015, Bosnjak *et al.*, 2020). Contrarily, beliefs are often formed following incomplete, inaccurate, prejudiced, paranoid, self-centric, or irrational information. As the most essential TPB element indicates the extent to which individual beliefs encourage or discourage the execution of intention, this study aimed to examine if knowledge determined stronger oil palm planter attitudes and preferences to utilise green pesticides.

Subjective Norm

As the second TPB indicator, subjective norms or beliefs indicate the normative expectations of significant others that induce perceived social pressure. The two primary subjective norm constructs are injunctive and descriptive norms. Injunctive normative belief is the anticipated or subjective likelihood involving the behavioural acceptance or rejection of referents or groups while descriptive normative belief indicates the extent to which significant others engage in the behaviour (Ajzen, 2020).

As previously mentioned, subjective norms denote social pressure in determining specific behaviours (Ajzen, 1985). Past research revealed a purchase intention-actual green product purchase behaviour correlation at both personal and social levels (Eze and Ndubisi, 2013; Liu *et al.*, 2012). Regardless, subjective norms were found to be either completely unrelated to purchase intention (Connell, 2010) or only denoted indirect effects (Gadenne *et al.*, 2011; Salazar *et al.*, 2013). As such, it is inadvisable to omit the elements from this research given the evident association of subjective norms with TPB. Planters' pro-social behaviours correspond to the perceived social pressure from subjective norms within the pesticide and sustainability contexts (Wang *et al.*, 2018).

Contrary to injunctive norms, descriptive counterparts emphasise actual individual actions (Dessart *et al.*, 2019). The widespread belief that individuals either perform or disregard specific behaviours significantly impacts how people behave in a given circumstance (Ahn *et al.*, 2020). Adoption of green pesticides might be a catalyst as a good practice from a sustainability standpoint, despite the lack of explicit regulatory compliance for green pesticide usage in actual practices. Notwithstanding, the adoption would rely on other affected situations, such as pest attack severity, cost-effectiveness, and other circumstances for holistic considerations.

Perceived Behavioural Control

As the third TPB construct, PBC reflects individual perceptions of the relative ease of or difficulty in performing favoured behaviours and potential access to necessary resources and opportunities (Ajzen, 1991; 2015). The PBC is hypothetically grounded on access control-oriented beliefs that relate to the availability of conducive conditions that assist or hinder behaviour execution. The possibility of a specific facilitating or inhibiting factor in a scenario of interest is indicated as a controlling factor (Ajzen, 2020). Although past studies often considered PBC to be equivalent to attitude and subjective norms, recent debates on TPB emphasised PBC as a moderator of both components (Bosnjak *et al.*, 2020; La Barbera and Ajzen, 2021). Additionally, research on various contexts demonstrated that strong PBC increased the relative significance of attitude and decreased the relative importance of subjective norms to predict intention (Barbera and Ajzen, 2020; Canova and Manganello, 2020; La Barbera and Ajzen, 2021). As such, this research strived to bridge the existing gap with PBC in TPB to forecast oil palm planters' green pesticide adoption behaviour.

Past studies revealed that PBC primarily impacted the willingness to buy and environmentally friendly product consumption (Ma *et al.*, 2012; Wang *et al.*, 2014), while other counterparts contradicted the findings (Arvola *et al.*, 2008). Other studies found no conclusive proof of a PBC-green purchase intention correlation following research scarcity (Joshi and Rahman, 2015). Given the retainment of PBC as an indicator in this novel green pesticide research based on its sound establishment in TPB compared to other green (organic food) consumption studies, this study may produce distinct results.

Malaysian Sustainable Palm Oil (MSPO)

The MSPO is a standard certification scheme owned by the Malaysian Palm Oil Certification Council (MPOCC), an independent organisation

established in December 2014. The MPOCC is accountable for the MSPO certification scheme development and implementation in Malaysia to highlight various sustainability principles for both independent and organised smallholders (Singh and Kumaran, 2016). Although MSPO certification was voluntary at the early implementation stage, the Malaysian government made the certification compulsory as of 1 January 2020 (Kumaran, 2019, 2021). The MSPO encompasses seven primary goals under sustainability principles, such as economic viability, social acceptability and ecological efficiency (Parveez *et al.*, 2021; Singh and Kumaran, 2016).

The Malaysian Palm Oil Board (MPOB) functioned as a working committee between 2011 and 2013 during the early stage of MSPO development to finalise the relevant standards before being delivered for public comment, submitted to SIRIM Berhad (Standard Development Agency or SDA), incorporated into the final draft, and adopted as the Malaysian Standard (MS) by the Department of Standards. The MSPO was approved by the Honourable Minister of Science, Technology, and Innovations in September 2013 and launched by the Deputy Prime Minister during the 2013 MPOB International Palm Oil Congress and Exhibition (PIPOC) (Singh and Kumaran, 2016). The MSPO system has since benefited the oil palm industry in multiple ways, such as environmental protection, safer working conditions and contributions to local sustainable development. The system has also fulfilled the demand for Certified Sustainable Palm Oil (CSPO) from environmentally sensitive markets following Kumaran (2019). Although the MSPO certification accreditation from MPOCC is valid for five years, each registered member must undergo a surveillance audit to ensure standard compliance (Kumaran, 2021).

Through MSPO standard requirements, it is possible to infer that the oil palm industry is encouraged to use environmentally friendly pesticides. From another perspective, training on pesticide handling must be frequently performed to overcome workers' lack of knowledge (Damalas and Eleftherohorinos, 2011; Ye *et al.*, 2013). Malaysia on the broad view of the workforce employed foreigners in oil palm estates. These foreign workers are having minimum educational backgrounds. Furthermore, they are presumably utilising languages that differ from their employers, causing employer-worker communication barriers. Hence, workers must undergo multiple training sessions to be aware of the minimum requirements for injury avoidance when spraying chemicals despite Personal Protective Equipment (PPE) being provided. Employees would benefit from green pesticide usage following its minimal toxicity and low health risk due to intoxication. A viable alternative, such as

the implementation of green pesticides is practically necessary to mitigate chemical hazards (worker intoxication). Current global studies are also seeking novel solutions, such as replacing synthetic pesticides with biological control (Cederlund, 2017; Fiola and Gill, 2017; Maizatul-Suriza *et al.*, 2017; Rajmohan *et al.*, 2020) serving these reasons while also being a long-term strategy for protecting workers' well-being.

RESULTS AND DISCUSSIONS

As the first characteristic emphasised in the attitude domain, resistance to change is perceived to be significantly associated with individual personality. Following the Big Five personality theory, individuals with low openness to novel experiences generally tend to resist change (Dessart *et al.*, 2019; George and Zhou, 2001). Under the behavioural momentum theory, behaviour resembles a mass-like quality in line with Newton's second law of gravity. The application of an external force to a moving object proportionally alters the object's velocity based on the degree of applied force and is inversely proportional to the item's mass (Craig *et al.*, 2014; Nevin and Grace, 2000).

In this vein, behaviour demonstrates a mass-like aspect that induces resistance to change and reinforces delivery in a stimulus setting towards the 'behavioural mass'. In the green pesticide adoption context, oil palm planters would choose to continue utilising synthetic pesticides or adhering to the conventional traditions taught by their seniors. Green pesticides are observed as novel modifications in place of traditional practices that cause explicit and implicit changes in daily routines and procedures, disruption in personal comfort zones, ambiguities and even perceived threats with insufficient knowledge of green pesticide application compared to current counterparts. Inevitably, the aforementioned implications instigate planters' resistance to change (Oreg, 2006; Özdemir-Güngör and Camgöz-Akdağ, 2018) and blatant disregard for green pesticides as a viable alternative. Thus, the first proposition is presented as follows:

Proposition 1: Oil palm planters' resistance to change influences the intention to adopt green pesticides

The second attitude involves risk tolerance. Past research on sustainability demonstrated risk tolerance to strengthen sustainability practice adoption (Trujillo-Barrera *et al.*, 2016), specifically in terms of budgeting. In other words, risk tolerance implies the degree to which people could tolerate uncertainty while making financial decisions (Grable, 2016). For example, risk could denote

attitudes that potentially impact the economic decisions of individuals with varying degrees of risk tolerance, particularly in consumption (Sharma and Chatterjee, 2021). As the end-users engaged in product purchase, usage and disposal, oil palm planters need to first evaluate all the possible risks associated with green pesticide pre-purchase. Grable (2016) indicated that financial planning models, investment appropriateness assessments and consumer choice frameworks significantly influence the essentiality of risk tolerance. In this vein, an individual's risk tolerance implies the ability to manage ambiguities. Given that planters' lower risk tolerance increased high green pesticide adoption possibilities, the second proposition is presented as follows:

Proposition 2: Oil palm planters' risk tolerance influences the intention to adopt green pesticides

Environmental awareness (EA) and environmental concern (EC) imply two types of knowledge conceptualisation. The EA definition corresponds to Altin *et al.*, (2014) connotation as the awareness of environmental issues and active engagement in environmental organisations. Inadequate knowledge and education, negative feelings and thoughts instigate low awareness levels that impact optimal sustainability adoption (Karatekin, 2014). Past local studies demonstrated that high EA levels did not imply significant environmental behaviour levels as a single predictor (Mei *et al.*, 2016) in line with a study conducted earlier in 2013 (Klöckner, 2013). Therefore, high EA is predicted within the oil palm community following industrial criticisms over several allegations from non-governmental organizations and western countries. The oil palm plantation sector is often associated with adverse claims, such as deforestation (Ferdous Alam *et al.*, 2015; Meijaard *et al.*, 2020), the welfare of endangered animals (orangutans and Sumatran rhinos) (Frank Vogelgesang, 2018), the transboundary haze that lowers air quality (Mohd Noor *et al.*, 2017), the violation of indigenous peoples rights to water sources through persistent chemical pollution (Leong *et al.*, 2007) and other environmental issues. The essentiality of EA in this study represents individuals' environmental knowledge, attitudes, beliefs and abilities in alleviating environmental issues. Thus, the third proposition is presented as follows:

Proposition 3: Oil palm planters with EA will have intentions to adopt green pesticides

Essentially, EC indicates an individual's consciousness of environmental vulnerabilities and the subsequent limitations of natural resources

(Kalafatis *et al.*, 1999). On a global scale, the recent EC notion indicates individuals' environmental concerns for the sake of human health and well-being rather than environmental degradation (Lou and Li, 2021; Nicolopoulou *et al.*, 2017). Following past research, gender indicated moderation effects on EC where males required more EC exposure compared to females in encouraging green purchase intention (Chen and Zhang, 2021; Dagher *et al.*, 2015; Malik *et al.*, 2019). Individual attention to value information, specifically regarding the level of concern for the environment, other human beings and animal welfare varied gender-wise (Dagher *et al.*, 2015; Eagly and Wood, 2012).

The role of gender is primarily highlighted in EC as the local oil palm industry is dominated by high-ranking males, such as managers and agronomists. Past research also indicated EC to be affected by location as individual preferences differed based on place of origin. For example, people from developed countries reflect higher EC than counterparts from other nations (Paul *et al.*, 2016), as individual attitudes are heavily influenced by culture (Singh and Gupta, 2013). Furthermore, the individuals (specifically Malaysians) are engaged in work with no time to perform environmental behaviours (Ramayah *et al.*, 2010). As EC could become a vital antecedent towards green pesticide adoption in oil palm plantations following the impacts of consumers' decisions regarding environmentally friendly purchase behaviours (Jain and Kaur, 2004, Kalafatis *et al.*, 1999), the fourth proposition is presented as follows:

Proposition 4: Oil palm planters with EC will have intentions to adopt green pesticides

High expectations of conduct in line with social acceptance or disapproval compel individuals to engage in socially acceptable or undesirable behaviours (Harris *et al.*, 2020). In the research setting, green pesticide adoption is highly recommended to all planters towards public acceptance as an example to other planters. As social acceptance or rejection is perceived to be highly influenced by injunctive standards rather than descriptive norms, the fifth proposition involving injunctive norms is presented as follows:

Proposition 5: Oil palm planters' friends or family will influence the intention to use green pesticides

As green pesticide adoption should be regarded favourably and as a norm for sustainable practices to induce a positive mood and planter's work performance, the sixth proposition involving descriptive norms is presented as follows:

Proposition 6: Agricultural sustainability efforts inspire oil palm planters to adopt green pesticides

Another component under subjective norm is the signalling motive. Although sustainability practices in the oil palm plantation sector potentially increase end user's acceptability of edible oil usage worldwide, consumers tend to emphasize eco-friendly goods to enhance the public image (Kushairi *et al.*, 2017; Nambiappan *et al.*, 2018; Sundaraja *et al.*, 2020). The presence of social pressure necessitates sustainable product (palm oil) development, particularly in European nations (Dessart *et al.*, 2019; van Dijk *et al.*, 2016). For example, the European farmers' effective mitigation of deforestation impacts and optimal environmental stewardship resulted in widespread product acceptance by end-users (Dessart *et al.*, 2019). Following the European sustainable practice adoption model, Malaysian oil palm planters could adopt green pesticides following end users signalling motives to reflect a positive public image or status and fulfil consumer expectations of sustainable palm oil. Signalling motives have been empirically reflected in multiple consumer behaviours based on a systematic review where consumers selected organic food to avoid harmful ingredients, synthetic pesticides, chemicals, additives and non-genetically modified organisms (GMOs) within developing countries (Kushwah *et al.*, 2019). The planters in this study chose to utilise green pesticides following market demand as a signalling motive to cultivate the culture of high-quality oil palms in line with fundamental agricultural principles. Hence, the seventh proposition based on signalling is presented as follows:

Proposition 7: Oil palm consumers signalling motives significantly impact oil palm planters' intentions to adopt green pesticides

Self-efficacy under Bandura's (2010) social learning theory is defined as the self-evaluation of a course of action for task accomplishment and objective attainment. Past research revealed PBC to reflect a similar meaning to self-efficacy regarding the personal convictions to perform particular activities involving physical and mental preparedness (Dang and Chou, 2019) and the degree of confidence in executing specific conduct (Ho *et al.*, 2020).

Reliable and relevant information is essential for oil palm planters to adopt a sustainable practice toward optimal performance levels. As planters potentially originate from a diverse set of knowledge, competence and experience, measuring the degree of self-efficacy towards green pesticide adoption is crucial to forecast readiness levels. Individuals with high self-efficacy levels tend to be

more competent and confident and make robust, persistent and genuine decisions (Dang and Chou, 2019). Ajzen acknowledged PBC and self-efficacy to be essentially similar in subsequent assessments as both elements measure people's confidence in specific activity performance. The PBC functions by enabling the participants to assess behavioural capacities and control over activities (Ajzen, 2019). As such, the eighth proposition involving self-efficacy is presented as follows:

Proposition 8: Oil palm planters are confident in the ability to adopt green pesticides

The green brand knowledge process offers information that catalyses consumers' ecological awareness (Aulina and Yuliati, 2017). Following (Akdeniz *et al.*, 2013) study on consumer behaviour, consumers tend to rely on product information to comprehend multiple options or feel confident about their decision-making abilities. In this vein, product knowledge is important to address sales opportunities and strengthen confidence in making consumer-oriented decision. As end-users who purchase, utilise and promote green products, oil palm planters are expected to act on similar behaviours following Akdeniz's prediction. Green brand knowledge acknowledges the fact that customers are drawn to a particular brand due to product familiarity and comprehension (Goodwin, 2000). Thus, the planters' intentions to adopt green pesticides could depend on product knowledge and familiarity and the acquisition of relevant information, skills, or experiences for green pesticide application in the field. The paucity of research involving the effect of green brand knowledge on green purchasing behaviour subsequently reflects the lack of a definitive outcome in this field (Joshi and Rahman, 2015). Thus, the ninth proposition is presented as follows:

Proposition 9: Oil palm planters with knowledge of utilizing green pesticides intend to implement them completely in the field

A common misconception regarding green pesticides is the high cost following price variations and ineffectiveness in pest eradication compared to their traditional counterparts. Based on past studies, people who perceived sustainable practice adoptions to be easily potentially engaged in such practices (Dessart *et al.*, 2019). Likewise, the lack of technical skills, time and necessary equipment would instigate the reluctance to adopt. Cost and benefit factors have catalysed work completion or goal pursuits (Hattie *et al.*, 2020) and affected planters' preference to utilise green pesticides based on 1) economic value, 2) adoption incentives, 3) personal pleasure, 4) environmental commitment

and 5) self-competence (modified from past research) (Eccles and Wigfield, 2020). As 'green' labelled products are often costlier at the point of market penetration following the absence of large-scale manufacturing (Berger, 2019), the high cost adversely impacts green choices, attitudes and dissuades people from making purchases (Joshi and Rahman, 2015).

Perceptions of green pesticides as premium-price products compared to conventional counterparts inevitably encourage planters to comply with old practices. Following past studies, Asian agricultural communities were more sensitive to potential losses compared to their Western counterparts (Cherian and Jacob, 2012; Dessart *et al.*, 2019). Additionally, the high costs countered ethical issues and reduced the attitude-behaviour gap in green product purchasing (Connelly *et al.*, 2011; Gleim *et al.*, 2013) while low green product pricing encouraged consumer purchasing (Eze and Ndubisi, 2013; Weisstein *et al.*, 2014). As perceived costs and benefits substantially influence oil palm planters' green pesticide adoption. Thus, the tenth proposition involving perceived costs and benefits is presented as follows:

Proposition 10: Oil palm planters who intend to adopt green pesticides will be influenced by the cost of implementing them

Profit maximisation is a corporate goal like the palm oil market growth worldwide and end-user market development. On another note, palm oil producers are compelled to execute sustainable production following consumer preferences. Thus, sustainable practices should be optimised by incorporating green pesticides as a fundamental concept to mitigate environmental effects. Perceived risk denotes the sense of insecurity associated with technological adoption and adversely impacts individual intentions (Hong *et al.*, 2020). For example, people typically exercise cautious behaviour when managing purchasing decisions at corporate levels. Moreover, the implementation of the Integration Management System (MSPO integrated with the Occupational Safety and Health Management System ISO45001:2018 and Quality Management System ISO 9001:2015) in oil palm plantations has catalysed risk-based thinking at all operational levels, including pesticide application. Specifically, risk-based thinking implies anticipating scenarios for risk and opportunity assessments and the potential impacts on objectives to preserve or improve intended outcomes (Ezrahovich *et al.*, 2017).

In line with previous studies, perceived risks encompass several constructs: 1) ecological risk (environmental threats, such as killing non-target animals, low biodiversity, and targeted pest resistance), 2) the economic risk that potentially instigates economic losses, 3) ethical risk that

relates to ecological risk, 4) health risk through conventional pesticide usage and 5) social risk that could alter social norms, values and beliefs (Xu *et al.*, 2020). Another component of perceived risk is human health concerns. Green pesticides serve to mitigate the risk of undesirable environmental effects, such as direct or indirect non-target organism poisoning, low biodiversity, and soil and water pollution (Basantia, 2017; Basantia and Rathore, 2017; Karunamoorthi, 2012a; Mahmood *et al.*, 2016; Mobki *et al.*, 2014; Singh and Singh, 2016). For example, pheromone traps for particular insects do not require human exposure to pesticides as the trapping method implies minimal work and limited chemical exposure (Ahmad *et al.*, 2017; Baker *et al.*, 2020; Marshall *et al.*, 2017; Ramle *et al.*, 2005; Stenberg, 2017). Palpably, perceived risk is a significant antecedent that facilitates oil palm growers' readiness toward green pesticide adoption. In this vein, the eleventh proposition is presented as follows:

Proposition 11: Oil palm planters' intention to use green pesticides will be influenced by the minimal hazards associated with their use in the field

In a study conducted in 2018, MSPO certification increased oil palm yields by 19% among Malaysian smallholders compared to the output pre-certification, thus resulting in an additional net profit of RM489/ha based on the average fresh fruit bunch (FFB) price in the year of 2018 (Arshad *et al.*, 2020). The data in this research are unsuitable for generalization following the small sample of certified MSPO smallholders due to low participation in the early stage of MSPO certification. Nevertheless, multiple avenues are offered for future studies as MSPO accreditation is compulsory in the local oil palm sector following its mandatory implementation in 2020. As MSPO facilitates planters and oil palm plantations towards sustainability and profitability following Arshad *et al.* (2020), the certification scheme could moderate attitudes and subjective norms to optimise the green pesticide adoption among oil palm planters. As such, the twelfth proposition is presented as follows:

Proposition 12: The MSPO plays a role as PBC to influence the planter's intention to adopt green pesticides

Findings and discussion for above mention propositions are summarized in Table 1.

Figure 4 depicts the conceptual framework or suggested model for the study, which comprises components in the TPB that is reflectively related to each relevant variable. The dotted line reflected the moderating impact of Perceived Behavioural Control on Attitude and Subjective Norm, which also

influenced intention indirectly. This research model will be assessed by utilising the Partial Least Square-Structural Equation Model (PLS-SEM) technique. PLS-SEM is employed for several reasons, but the most significant is that the model includes second-order components that affect the TPB and focuses on theory development and prediction rather than theory testing, as is advised if Covariance Based-

SEM is used. The interrelationship between all the variables will simultaneously be modelled using the SmartPLS software. All constructs are multi-items and conceptualized as (1) formative for the first order and (2) reflective for the second order. Reflective constructs aim to identify measures that are correlated, have unidimensionality and are expected to have strong internal consistency.

TABLE 1: RELEVANT LITERATURE AND RE-CATEGORISATION BASED ON TPB

Factors	Source	Category
Resistance to change	(Craig <i>et al.</i> , 2014), (Nevin, 1992; Nevin and Grace, 2000), (Oreg, 2006), (Özdemir-Güngör and Camgöz-Akdağ, 2018), (Dessart <i>et al.</i> , 2019), (George and Zhou, 2001)	Attitude
Risk tolerance	(Trujillo-Barrera <i>et al.</i> , 2016), (Grable, 2016), (Sharma and Chatterjee, 2021), (Dessart <i>et al.</i> , 2019)	Attitude
Knowledge-EA	(Haron <i>et al.</i> , 2005), (Ajzen, 2020), (Kalafatis <i>et al.</i> , 1999)	Attitude
Knowledge-EC	(Altin <i>et al.</i> , 2014), (Paul <i>et al.</i> , 2016), (Ramayah <i>et al.</i> , 2010), (Singh and Gupta, 2013), (Karatekin, 2014), (Klöckner, 2013), (Mei <i>et al.</i> , 2016), (Ferdous Alam <i>et al.</i> , 2015), (Meijaard <i>et al.</i> , 2020; Meijaard and Sheil, 2019), (Frank Vogelgesang, 2018), (Mohd Noor <i>et al.</i> , 2017), (Leong <i>et al.</i> , 2007), (Lou and Li, 2021), (Chen and Zhang, 2021), (Dagher <i>et al.</i> , 2015), (Malik <i>et al.</i> , 2019), (Eagley, 2013), (Jain and Kaur, 2004), (Kalafatis <i>et al.</i> , 1999)	Attitude
Injunctive norm	(Dessart <i>et al.</i> , 2019), (Harris <i>et al.</i> , 2020), (Ajzen, 1991), (Ahn <i>et al.</i> , 2020) (Kalafatis <i>et al.</i> , 1999)	Subjective norm (Ajzen, 1985; 1991; 2020), (Eze and Ndubisi, 2013), (Liu <i>et al.</i> , 2012), (Gadenne <i>et al.</i> , 2011), (Connell, 2010), (Wang <i>et al.</i> , 2018)
Descriptive norm	(Dessart <i>et al.</i> , 2019), (Ahn <i>et al.</i> , 2020), (Kalafatis <i>et al.</i> , 1999)	Subjective norm
Signalling motive	(Nambiappan <i>et al.</i> , 2018), (Sundaraja <i>et al.</i> , 2020), (Dessart <i>et al.</i> , 2019), (van Dijk <i>et al.</i> , 2016), (Kushwah <i>et al.</i> , 2019)	Subjective norm
Self-efficacy	(Bandura, 2010), (Dang and Chou, 2019), (Ho <i>et al.</i> , 2020)	PBC (Ajzen, 1991; 2015, (Bosnjak <i>et al.</i> , 2020), (Bandura, 2010), (Caputo, 2020), (Ma <i>et al.</i> , 2012), (P. Wang <i>et al.</i> , 2014), (Arvola <i>et al.</i> , 2008), (Joshi and Rahman, 2015)
Green brand knowledge	(Aulina and Yulianti, 2017), (Akdeniz <i>et al.</i> , 2013), (Mei <i>et al.</i> , 2016), (Goodwin, 2000), (Joshi and Rahman, 2015)	PBC
Perceived costs and benefits	(Dessart <i>et al.</i> , 2019), (Hattie <i>et al.</i> , 2020), (Eccles and Wigfield, 2020), (Berger, 2019), (Joshi and Rahman, 2015), (Biswas and Roy, 2015), (Cherian and Jacob, 2012), (Connelly <i>et al.</i> , 2011), (Gleim <i>et al.</i> , 2013), (Eze and Ndubisi, 2013), (Weisstein <i>et al.</i> , 2014)	PBC
Perceived risks	(Biswas and Roy, 2015), (Cherian and Jacob, 2012), (Dessart <i>et al.</i> , 2019), (Connelly <i>et al.</i> , 2011), (Gleim <i>et al.</i> , 2013), (Eze and Ndubisi, 2013), (Weisstein <i>et al.</i> , 2014), (Ezrahovich <i>et al.</i> , 2017), (Xu <i>et al.</i> , 2020), (Basantia and Rathore, 2017), (Karunamoorthi, 2012b), (Mobki <i>et al.</i> , 2014), (Singh and Singh, 2016), (Ahmad <i>et al.</i> , 2017), (Baker <i>et al.</i> , 2020), (Stenberg, 2017), (Sapbamrer and Thammachai, 2020), (Gunnell <i>et al.</i> , 2017), (Lee <i>et al.</i> , 2021), (Sulaiman <i>et al.</i> , 2019)	PBC
MSPO	(Arshad <i>et al.</i> , 2020), (Singh and Kumaran, 2016), (SIRIM, 2013a; SIRIM, 2013b). (Damalas and Eleftherohorinos, 2011; Kumaran, 2021; Rajmohan <i>et al.</i> , 2020; Ye <i>et al.</i> , 2013)	PBC

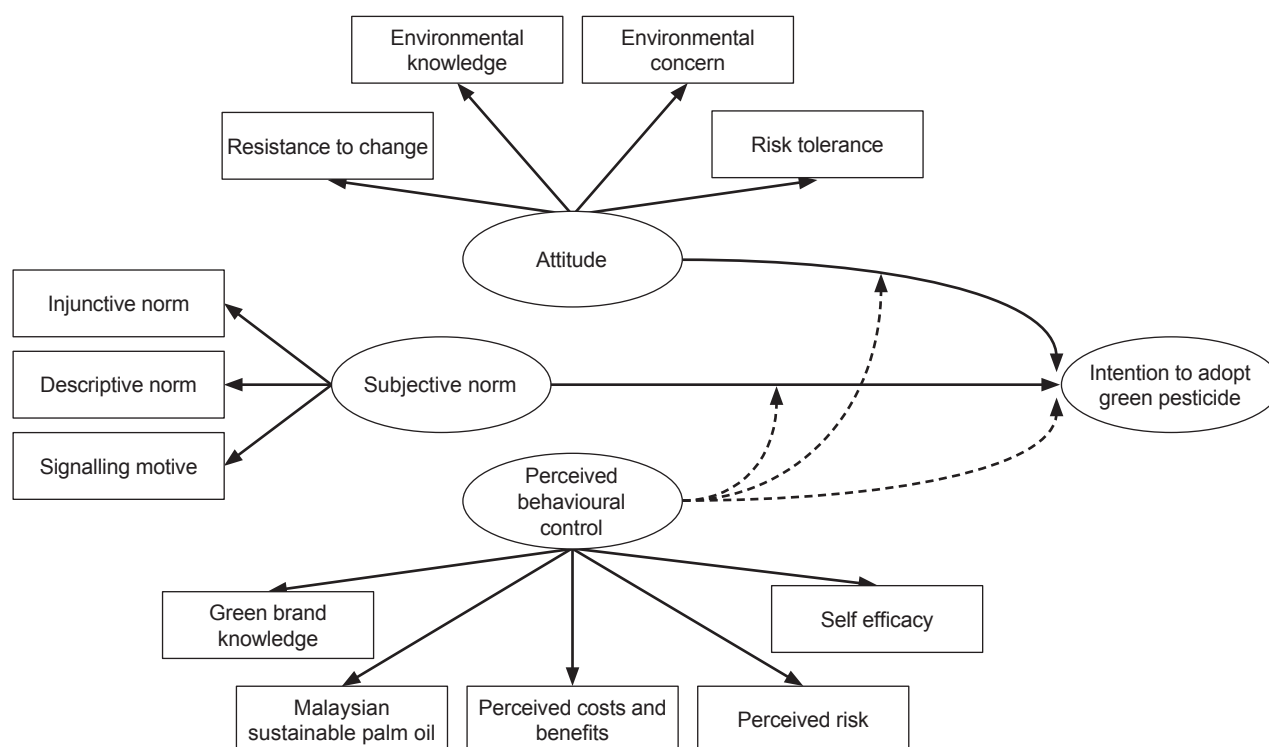


Figure 4. Conceptualised research framework for intention to adopt green pesticides among oil palm planters

CONCLUSION

This conceptualisation provided the framework of determinant factors that influence green pesticide adoption among Malaysian oil palm planters. The TPB was incorporated into this study following its well-established concept that indicated power prediction over human intention or behaviour. The conceptual paper has included sufficient information on the feasibility and addressed the urgency for further development. Despite multiple breakthrough findings of green pesticides through research and development, attempts to facilitate oil palm planter adoption raised questions involving their intention levels, thus highlighting gaps in knowledge. This paper has emphasised the crucial and expanded determinant factors that could influence oil palm planters' intentions to use and the moderating role of government regulations that could enhance the intention to use green pesticides among oil palm planters. In this vein, future studies are necessary to address such questions and test the conceptualisation through empirical research that could determine the relative influence of the determinant factors on the intentions to use green pesticides. This paper and future empirical research are expected to benefit key oil palm stakeholders, signal manufacturers to market sustainable pesticide products, and catalyse government bodies or policymakers towards optimal policy implementations for sustainable and responsible consumption of pesticides in the oil palm industry.

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DIGITAL MONITORING AND REPORTING SYSTEM OF OIL PALM FRESH FRUIT BUNCH (FFB) TRANSACTIONS: A CASE STUDY AMONG SUSTAINABLE OIL PALM GROWER COOPERATIVE IN PENINSULAR MALAYSIA

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ABSTRACT

Currently, there is a gap in Fresh Fruit Bunches (FFB) traceability among smallholders until it reached the oil palm mill via dealers. ICT-based intervention at the FFB dealers to record their daily transactions is able to address these issues. The need for this system arises due to the current limitation on getting more accurate and systematic data on the FFB transactions among smallholders. This article presents the development of an information technology (IT) system known as Kebolehejekan Informasi Pekebun Kecil Sawit (KIPS) phase 2 to address the current gap in collecting data on FFB transactions among smallholders by linking dealer fruit (DF) via technology. Other than that, a case study and survey methodology among 14 Sustainable Oil Palm Grower Cooperative (KPSM) in Peninsular Malaysia was carried out to assess the adoption, challenges and effectiveness of the system as well as the understanding of their current record-keeping practices. KIPS portal system was developed with three user modules of admin, dealer fruit and smallholder. KPSM found KIPS is generally easy to use. However, the limiting factors were the time, performance and productivity in using KIPS which might hinder their attitude and behavioural intention to use KIPS. Lack of time and resources emerges as the main problem in using the KIPS system. Overall, most of the KPSM were able to submit their report through KIPS within the stipulated period. The findings of this study can serve as a basic framework for the development of a traceability system for various related industries.

Keywords: digitisation, monitoring system, oil palm fruit dealers, traceability, smallholders.

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INTRODUCTION

Malaysia is well known as one of the major world players in the palm oil industry. Malaysian palm oil is mainly exported to India, China and the European Union (EU) (Parveez *et al.*, 2022). Apart from internal production challenges, the palm oil industry also faces external challenges such as changes in policy by importing countries, trade barriers and adverse campaigns. There have been various conditions established over the years for

palm oil, especially for the export market to the EU. The announcement from the EU which is committed to only buying certified sustainable and traceable palm oil from 2020 onwards has increased the commitment towards sustainability in Malaysia. The heightened requirement imposed by importing countries had driven the sustainability effort by producing countries in the global trade. Malaysia, as one of the major palm oil exporters, has introduced various strategies to fulfil the requirement imposed by the importing countries. One of the efforts is the introduction of Malaysia's certification standard known as Malaysian Sustainable Palm Oil (MSPO) (Parthiban *et al.*, 2021a). MSPO implementation in Malaysia has been made mandatory by the government since 2017. However, the mandatory

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implementation of MSPO for smallholders has been extended given the various challenges affecting their production.

The oil palm fruit dealers (DF) are the intermediaries in the upstream supply chain linking oil palm producers with oil palm mills. Dealer's activities such as purchasing, moving and selling FFB are registered and licensed under the Malaysian Palm Oil Board (MPOB) licensing regulations. According to MPOB (2021), there are around 3460 registered DF in Malaysia as of 2021 (Table 1).

The government's initiatives toward empowering smallholders resulted in the establishment of cooperatives to group smallholders together and establish a business model (Parthiban *et al.*, 2021b). Through these initiatives, MPOB assisted independent oil palm smallholders in establishing Sustainable Oil Palm Grower Cooperative (KPSM) all over the country. One of the immediate business opportunities recommended by MPOB is to establish an oil palm fresh fruit bunch (FFB) collection centre to initiate the business of buying and selling FFB. MPOB provide an initial financial grant and assistance to set up the business to help smallholders to sell FFB directly to the oil palm mill.

MPOB via the extension services has been tasked to assist independent oil palm smallholders to be certified under MSPO Certification. Independent oil palm smallholders in Malaysia are categorised as those who own oil palm land of less than 40 ha. Based on MSPO Part 2 (2013) for independent smallholders, there is a requirement under principle 2 to keep records of FFB sales. However, there is a gap in MSPO implementation among oil

palm smallholders in retrieving the yield data of each smallholder. Not all smallholders can keep consistent records of their FFB yield. Therefore, it poses challenges to the extension agent to efficiently retrieve the FFB yield record of each smallholder, especially to comply with the MSPO requirement on traceability (Parthiban *et al.*, 2022b). Currently, FFB yield records are gathered manually by extension agents either through smallholder records or with the help of dealers in preparation for the MSPO audit. This poses a huge manual task for extension agents especially when the number of smallholders increases for each surveillance audit. Therefore, there is an urgent need to digitalise the reporting of FFB transactions among smallholders and dealers.

This article presents the development of an information technology (IT) system known as *Kebolehejekan Informasi Pekebun Kecil Sawit* (KIPS) version 2 to address the current issues in collecting data on FFB transactions among smallholders by linking Dealer Fruit (DF) via technology. This study is a continuation of a previous study conducted by Parthiban *et al.* (2017a) with further improvement to the overall system. The previous study has shown that a similar system known as KIPS version 1 is able to improve FFB yield recording and monitoring by minimising the gap related to traceability. However, it needs improvements in the method for data entry to enable a more efficient way of gathering FFB yield data among smallholders. The use of a QR Code embedded smartcard was proven not to be an effective method for data entry as most of the smallholders were not able to be present and bring the card for every FFB transaction. Therefore, the main objective of the current study is to identify and develop an effective method and system to record the daily FFB transaction data by KPSM which also acts as the DF. Other than that, this study aims to assess the adoption and acceptance of the system as well as the understanding of their current record-keeping and FFB transaction practices.

LITERATURE REVIEW

Digitisation in Agriculture Sector

Over the years, digitisation has evolved and changed how people communicate and interact. Digitisation has affected every industry including agriculture in driving advances in labour productivity, increasing farmers' income, addressing traceability issues, connecting producers and consumers and others. Information and Communication Technology (ICT) is defined as the use of a range of technologies for gathering, storing, retrieving, processing, analysing and transmitting information (Geraldine, 2020). ICT application in agriculture can provide both direct and indirect benefits. The direct application involves the use

TABLE 1. NUMBER OF OIL PALM FRUIT DEALERS (DF) IN MALAYSIA ACCORDING TO STATES AS OF DECEMBER 2021

State	Number of DF
Johor	908
Melaka	62
Negeri Sembilan	110
Selangor	316
Wilayah Persekutuan	7
Kelantan	60
Pahang	406
Terengganu	121
Kedah	94
Perak	585
Perlis	0
Pulau Pinang	18
Sabah	490
Sarawak	283
Malaysia	3 460

Source: MPOB (2021).

of ICT which can contribute to improvements at the farm level such as an increase in productivity and yield. Indirect application of ICT involves the use of information by farmers gathered through ICT tools to make a quality decision which can lead to efficiency in management. While ICTs can significantly affect efficiency, resilience and inclusion in developing countries, new emerging innovations such as the Internet of Things, Cloud Computing and Big Data are increasingly revolutionising agriculture in developed economies (FAO, 2018). A digital revolution such as of Internet of Things (IoT), sensor technologies, big data and cloud computing has a very promising application in agriculture (Bronson and Knezevic, 2016; Himesh *et al.*, 2018). However, it is often not fully adopted by the agriculture industry, especially small-scale farmers and dealers. Data collection in farming still lacks the application of digitisation to make use of the huge data available to predict and direct future agriculture production practices (Bronson and Knezevic, 2016). ICT has been a significant tool in elevating socio-economic development in various sectors where they are well-adapted and integrated (FAO, 2018). ICT intervention is able to support efficient data collection which can be used for decision-making by farmers and policymakers (Delerce *et al.*, 2016) and tools for farm management for efficient recording and analysis of data (Rossi *et al.*, 2014). ICT intervention is known to be more cost-effective for data collection, monitoring and evaluation of agriculture-based projects compare to traditional methods (Hammond *et al.*, 2017).

Digitisation in Palm Oil Industry

A comprehensive traceability system linking all the stakeholders within the supply chain is necessary to further incorporate sustainability in the palm oil industry in Malaysia. Traceability solutions are important especially for smallholders to lessen the burden of data keeping and collection (Shukla *et al.*, 2017). Most of the independent smallholders in Malaysia are selling FFB via the middle man known as oil palm fruit dealers (DF) rather than directly selling to oil palm mills due to the small scale of FFB production. DF plays an intermediate role between producers/smallholders and mills (Parthiban *et al.*, 2022a; Rahman *et al.*, 2009). DF collects and buys from smallholders and sells to mills in bulk (Ishak *et al.*, 2016). MPOB has been tasked to provide licenses and regulate the industry including DF. MPOB has established certain guidelines on the type of records to be kept by dealers such as daily and monthly records, payment vouchers and many others. However, most of the DF is using manual methods such as books or paper for record-keeping rather than a computerised or digital approach (Parthiban *et al.*, 2017a). As for farmers, most of them are not

keen on record keeping unless it is encouraged and facilitated by external groups such as NGOs and farmer's associations and it normally involves simple data gathering for a specific purpose (Kuteesa & Kyotalimye, 2019; Minae *et al.*, 2008). Despite the requirement of certification to keep documents and records, most of the smallholders did not keep the relevant records (Brandi *et al.*, 2015; Nurhayati *et al.*, 2020). The lack of record keeping is mainly attributed due to illiteracy level, time constraints, size of landholding and lack of awareness (Annette *et al.*, 2019). This has resulted in inefficiency in record keeping and retrieving the data among smallholders and dealers. Therefore, there is an apparent gap in FFB traceability starting from the smallholder's plot until it reached the mills through middlemen. From mills onwards, most of the FFB is traceable as they have their traceability mechanism in place. ICT-based market information helps farmers to avoid exploitation by middlemen (Anoop *et al.*, 2015). Oil palm plantations including independent oil palm smallholders are vulnerable to FFB theft, especially during the period of the high price of oil palm (Vermeulen *et al.*, 2006). FFB losses due to theft in Cameroon are estimated to be between 36%-45% (Ajambang *et al.*, 2016). The stolen FFBs are normally sold illegally to middlemen using the unauthorised license of other smallholders (Parthiban *et al.*, 2017a). Currently, there is no effective mechanism in place to address these issues at the buyer's end except to lodge a police report. Therefore, the application of technology can address these issues by triggering an automated report of unusual or substantial FFB yield records based on the size of the landholding. This is relatively hard to achieve using manual reporting.

Stanton (2000) emphasises the role of locally based agribusiness to fill the diminishing role of government for the development of small-scale producers such as smallholders. Locally based agribusiness typically operates in rural areas to provide services to smallholders by combining the production and relying on the scale. The establishment of cooperative structures such as Sustainable Oil Palm Grower Cooperative (KPSM) among oil palm smallholders in Malaysia has seen various growth over the years. As of 31 March 2022, 69 KPSMs have been established all over the country with 60 of them having already conducted the business of selling FFB directly to the mills. From 2016 till February 2022, they have transacted a total of 1 119 362.63 tons of FFB which are spearheaded by smallholders themselves with the help of MPOB. Azman *et al.* (2015) reported an increase in income among smallholders who sell directly to mills via KPSM due to better prices from mills.

There have been various efforts to address traceability issues in the palm oil supply chain in Malaysia. Roundtable on Sustainable Palm Oil (RSPO) has developed *PalmTrace* as a traceability

system for certified palm oil products from mill onwards. Similarly, the Malaysian Palm Oil Certification Council (MPOCC) has launched an IT platform known as MSPO Trace to achieve 100% traceability of the palm oil supply chain (MPOCC, 2019). Recently, Malaysian Palm Oil Council (MPOC) have announced it is developing blockchain technology to improve the traceability of the Malaysian palm oil supply chain (MPOC, 2020). Most of these initiatives do not have detailed traceability information established from smallholders to dealers. On the other hand, bigger oil palm plantations can implement traceability systems within their ecosystem. Malaysia's biggest palm oil producer, Sime Darby Plantation (SDP) has developed publicly accessible data that allows anyone to trace their product down the mill, plantation and third-party plantations. However, this is not the case for independent oil palm smallholders. Currently, there is no defined way to trace or monitor FFB yield among smallholders who are normally selling via middlemen such as dealers and cooperatives. Small farmers are still lacking in the effective use of technology in managing their farms. Intervention and influence of dealer fruit or middlemen have been significant in the supply chain to connect smallholders with millers. Hence, there is a need for an information technology (IT) system to address the gap and provide an efficient way to gather FFB transaction records among smallholders.

ICT applications can play a major role in efficient data collection and generate fast information for decision-making (Delerce *et al.*, 2016). Therefore, ICT-based intervention at the middlemen or better known as oil palm DF is one of the efficient ways of gathering the FFB transaction data and as a means of traceability among smallholders. This is because FFB dealers are the crucial traceability point connecting the smallholders and millers. DF can provide the information needed especially for traceability among smallholders. The information management system can be classified into different groups (Varga *et al.*, 2010):

- Internal management system (within actors): traceability within the internal business connected to the final product.
- External (among actors): traceability between external authors within the supply chain.
- Whole chain system: traceability spanning across different sectors.

The different perspective within the stakeholder's category offers different challenges and views on applying new technology, especially traceability solution. The benefits of applying new technology from an operational perspective are always easy to visualise. However, there are many hesitance and challenges within the different

perspectives. From a financial perspective, an organisation might reluctant to share or make public any information as they have spent cost in gathering the information and they might view it as a strategic advantage over their competitor. From a human perspective, people might reluctant to adopt new changes to their concerns which might add additional workload or losing their strategic value within the organisation (Hirbli, 2018). Small and medium enterprises (SMEs) in Malaysia have a low adoption level of technology (Alam *et al.*, 2007). Introducing technology need to be supported with enough resource such as adequate and competent staff to enable a better adoption level (Nor Hazana *et al.*, 2013). Higher literacy levels on information technology and the intention to increase production in the future are two driving factors among farmers in adopting new technology in farm management (Lima *et al.*, 2018). In Malaysia, most of the oil palm smallholders are between 50 and 70 years old which might pose some challenges in adapting to new technology (Parthiban *et al.*, 2017b). Most of the non-internet users (51.8%) in Malaysia are 60 years old and above (MCMC, 2020). Therefore, the active involvement of the younger generation within the community with ICT knowledge can help farmers access information through ICT (Mukhtar *et al.*, 2015). Non-internet users in Malaysia were not using the internet due to a lack of interest, being too old to learn and having no device (MCMC, 2020). Other than that, the majority of internet users in Malaysia went online for social purposes such as communicating by text and visiting social networking platforms compare to getting information or reading online publications (MCMC, 2020). Adoption and application of ICT in agriculture are still poor among many farmers due to a lack of internet connectivity, missing capacity building and low usability of ICT applications (Eitzinger *et al.*, 2019).

A better understanding of the benefits provided by new technology has shown a positive effect on farmers' willingness to pay for new technologies (Stephen *et al.*, 2020). Lack of incentives and low awareness of the benefits of adopting new technology might pose a strategic challenge to users (Hoyer *et al.*, 2019). However, the costs and benefits of traceability alone might not influence small businesses and small-scale farmers to participate in the traceability system (Meuwissen *et al.*, 2003). The quickest way for users to uptake any new technology would be if they are required by legislation or market requirements. Parthiban *et al.* (2022b) reported that the lack of commitment among FFB dealers to use ICT based approach at the initial adoption might be due to a lack of legislative requirements. However, a softer approach would be to incentivize use by demonstrating how new tools might add value to their business or through

financial incentives such as grants or subsidies (Rose *et al.*, 2016).

METHODOLOGY

Materials

This research comprised various planning, development, testing and assessment process (Figure 1). In the planning and user requirement assessment, field visits to five KPSMs with different existing software platforms were conducted to check their existing system and to gather feedback on the proposed idea of the KIPS system. Agricultural ICT development for smallholders needs to be designed with inputs from farmers and other stakeholders involved (Eitzinger *et al.*, 2019). Based on the feedback and review from the previous study, a process flow of the system was developed. The main system then was developed involving various modules. Two of the KPSMs were selected to further test the system for any further improvements and fine-tune the final system. Furthermore, a security penetration test was conducted to assess the security vulnerability of the system. Two sessions of training were conducted to train all 14 managers of KPSM on how to use the system. After the training, all the KPSMs were allowed to try the system for 1 week before commencing the pilot project for 2 months.

Gap and Intervention

The proposed intervention by the KIPS system at the dealer will address the traceability gap between smallholders and millers (Figure 2). Dealers will be the main intervention point to provide information on FFB transactions between smallholders and millers.

The current process of weighing FFB at the weighbridge involves a series of the process (Figure 3). The vehicle transporting FFB will be weighed once it enters the weighbridge area before it goes to the FFB collection platform to unload the FFB. Once the FFB is completely unloaded, the empty vehicle will be weighed again to determine the net weight of the FFB. The data on the net weight will be recorded by the existing weighbridge system with other basic information. However, other relevant data, *e.g.*, MPOB license number, acreage and FFB price are mostly stored and synchronised manually depending on individual dealers. Therefore, the proposed intervention by the KIPS system will allow data recording to be digitalised where all the basic non-variable information such as acreage, GPS coordinates and other relevant data are readily uploaded into the system and synchronised automatically without the need for manual intervention.

Specification of KIPS System

Currently, most of the DF is using the integrated weighing software that is often delivered as a package with the weighbridge infrastructure. This software varies between DF based on the type of weighbridge infrastructure. Initially, we considered developing fully integrated software by tapping into the Application Programming Interface (API) of the existing weighbridge system to enable direct communication with KIPS. However, there are different models of weighbridge with different weighing software used by dealers. Given the funding limitation, integrating with all the different weighing software and hardware will translate to higher development costs as it requires various changes in both software and hardware across the different models. Furthermore, it will be troublesome for technical support services to cater to individual complaints for nationwide applications; hence we decided not to use this method. Any traceability system must be simple, cost-effective and reported in harmonized format to receive widespread adoption across the network (Bhatt *et al.*, 2013). Therefore, it is proposed to use a portal system with a module to upload data using Comma Separated Values (CSV) format for easier data entry and data upload (Figure 4). This similar application has been incorporated into a smart farming platform for pig livestock where user can export existing data in Excel files into the system which eliminate the duplication of work (Zimpel *et al.*, 2020). ICT development should identify the local issues of connectivity, user capacities and cultural background to reduce the gap with marginal groups of smallholders driven into digital poverty (May and Diga, 2015). Based on the pre-assessment, some of the weighing software used by KPSM can generate reports of FFB transactions in excel spreadsheet format. Therefore, using the existing report generated via the excel spreadsheet and directly uploading this data with other additional information will reduce time and error during data entry.

The three-tier architecture of the KIPS system is shown in Figure 5. The presentation tier (front) is a web-based user interface for all the stakeholders to feed data and view information. The Frontend uses Bootstrap with the Progressive JavaScript Framework (VueJS) as its UI framework solution. The Backend system was built using the PHP Laravel framework and MVC (model-view-controller) architecture with MariaDB. The business logic (application) is executed by NGinX Web Server with Debian OS.

User Module

The KIPS system contains 3 user modules of admin, dealer fruit and smallholder with different

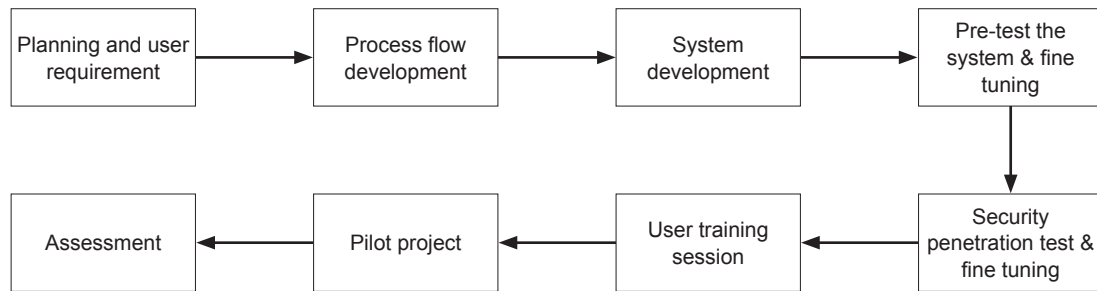


Figure 1. General flowchart of the research methodology.

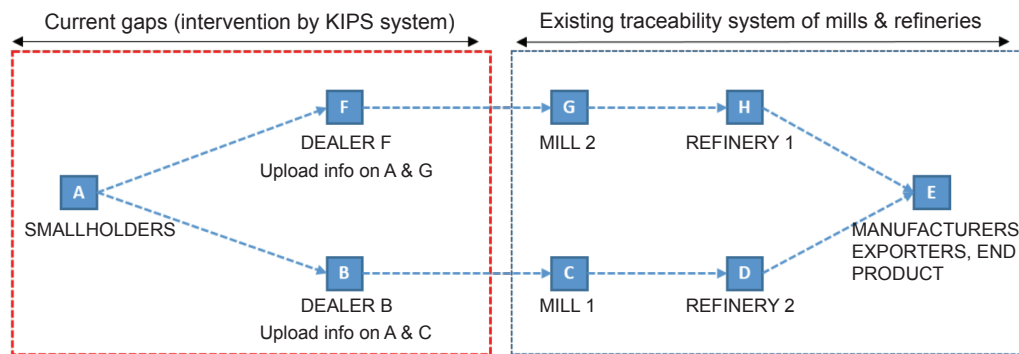


Figure 2. The flow of information for traceability using the KIPS system.

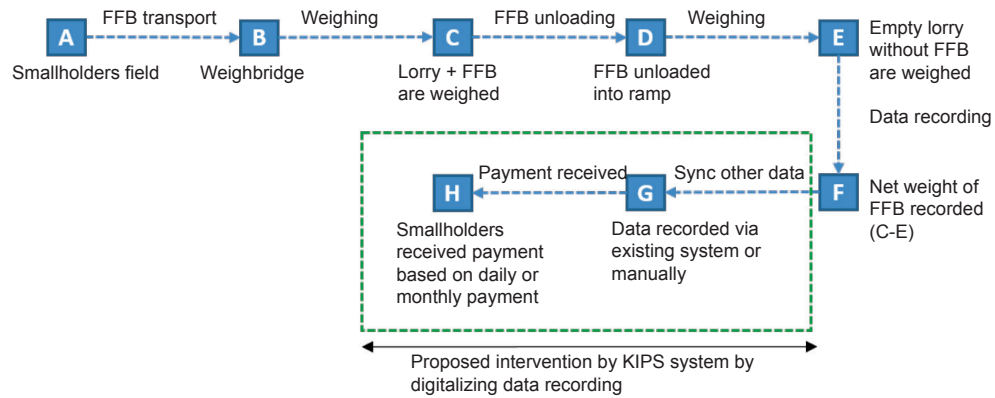


Figure 3. Existing process flow at the weighbridge and the proposed intervention by the KIPS system.



Figure 4. The operational flow of the KIPS system.

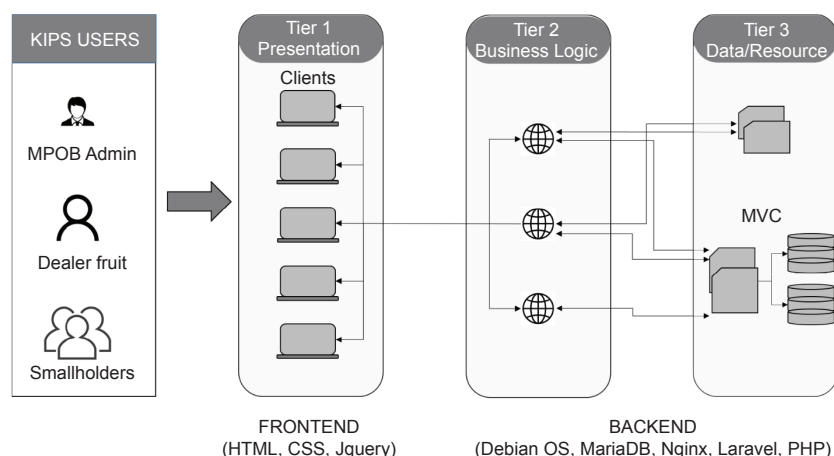


Figure 5. The three-tier architecture of the KIPS web system.

levels of access (Figure 6). Admin can view the entire transaction records while DF and smallholders can only view their respective transactions. Each user can register using their unique MPOB license number as the user's name to start using the system.

Data Entry

Data entry modules were developed either as individual data entries for each transaction or as group uploads as a whole (Figure 7). Individual data entry requires DF to key in the transaction for each smallholder while group upload allows DF to upload the entire daily transaction as a whole using the CSV file format. CSV file was used as it allows data to be saved in a tabular format, making them easier to open with most spreadsheet programs regardless of the software used. This method offers flexibility to DF as they can use their existing report generated from their weighing software and upload it with some additional inputs and formatting. However, it requires more attention from KPSM to make sure the correct data are uploaded compared to individual data entries. Ideally, data collection must occur regularly or if possible, as soon as it has happened (Bhatt *et al.*, 2013). The data on the system will be near real-time as we proposed that each KPSM upload their daily FFB transaction data within 24 hr or latest before 3 pm on the next day. This method will allow them to upload the data from anywhere, especially in places that lack internet connectivity.

Data Synchronisation

Basic non-variable information on smallholders such as name, area, lot number, phone number, identity card number and Global Positioning System (GPS) coordinates are readily uploaded into the system. Similarly, non-variable information on DF and mill such as the GPS coordinate of

the weighbridge location, the GPS coordinate of the mill and the license number were uploaded into the system. Dealers only need to upload daily FFB transaction data based on the license number of smallholders as a reference point. Other non-variable basic data will be synchronised automatically by the system to generate the relevant report (Figure 8). As an example, the system will auto-assign the GPS location of the weighbridge, palm oil mill and smallholder's plot based on the identification of the user login, and list of the palm oil mill and smallholder's plot respectively. The overall movements of FFB based on the destination from farm to DF to mill can be viewed on a map based on OpenStreetMap® offers visual traceability. In addition, an algorithm has been introduced into the system to trigger a report of unusual or substantial FFB yield records based on the size of the landholding. This information helps MPOB to identify license holders with substantial recorded FFB yields of more than the normal average yield in relation to their farm size. Further verification of the reported data can be conducted with particular smallholders or dealers as a way to curb the sales of stolen FFB via the unauthorised use of smallholder's licenses or sales made without a license.

Methods

This study was conducted among 14 KPSM in Peninsular Malaysia which have conducted the business of selling FFB via a weighbridge system (Figure 9). The KPSM in Peninsular Malaysia was purposively chosen compared to Sabah and Sarawak as it is nearer to MPOB headquarters for frequent monitoring. The pilot project was conducted for a period of two months in November and December 2021. During the pilot project, KPSM is required to upload their daily FFB transaction before 3 pm the next day into the KIPS portal. The data entry

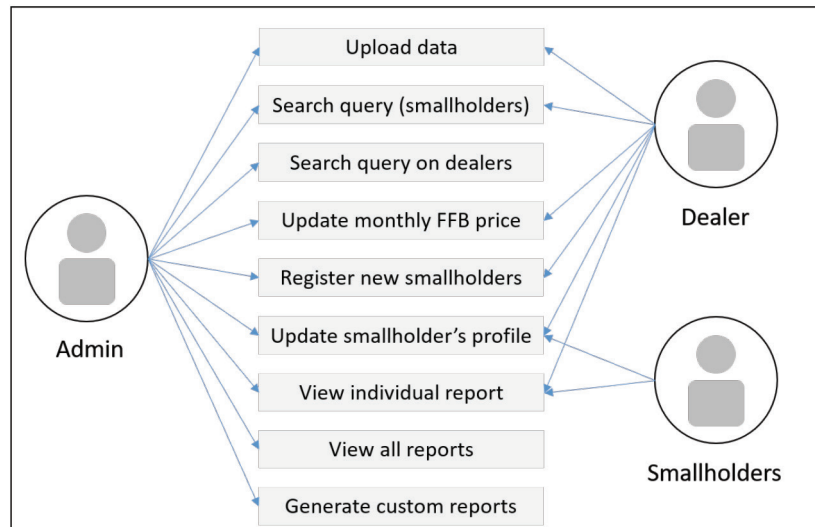


Figure 6. User module of the KIPS system with the respective feature.

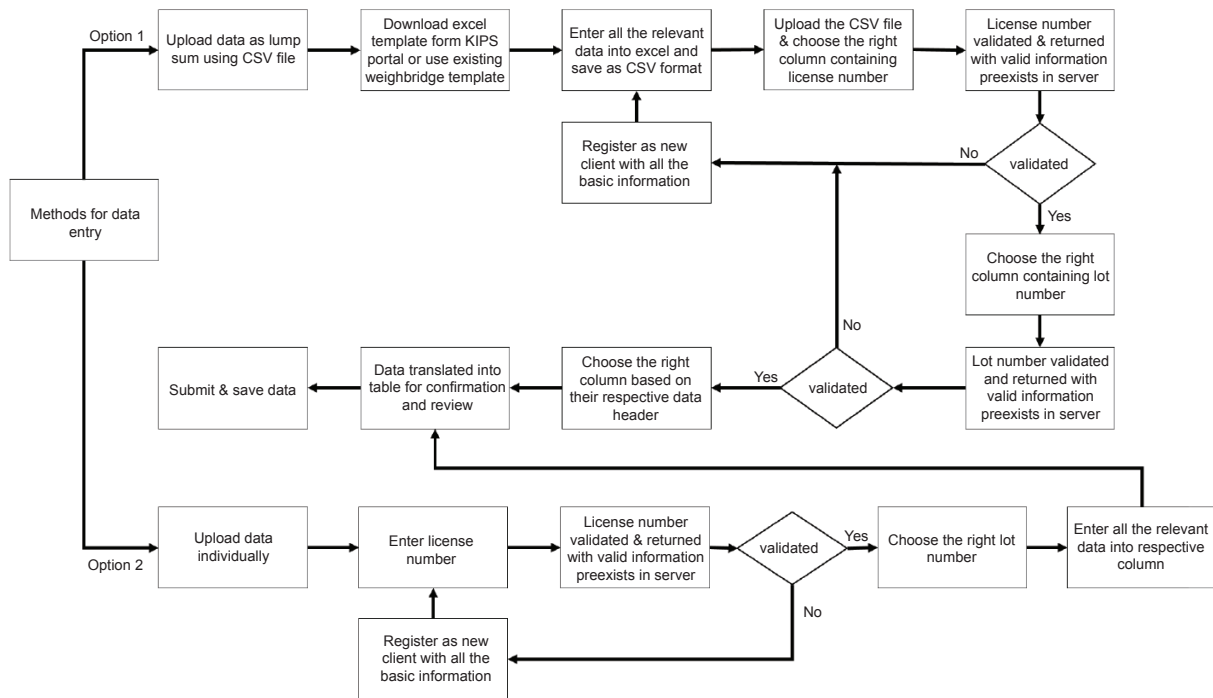


Figure 7. Process flow for data entry.

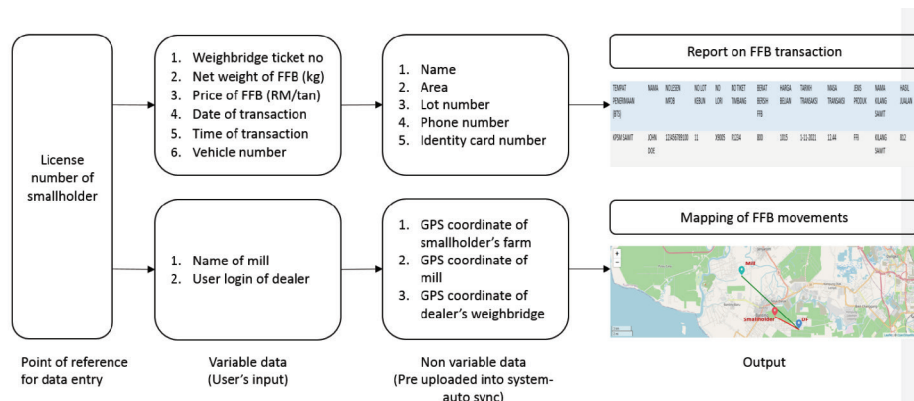


Figure 8. Flow for data synchronisation and report output.

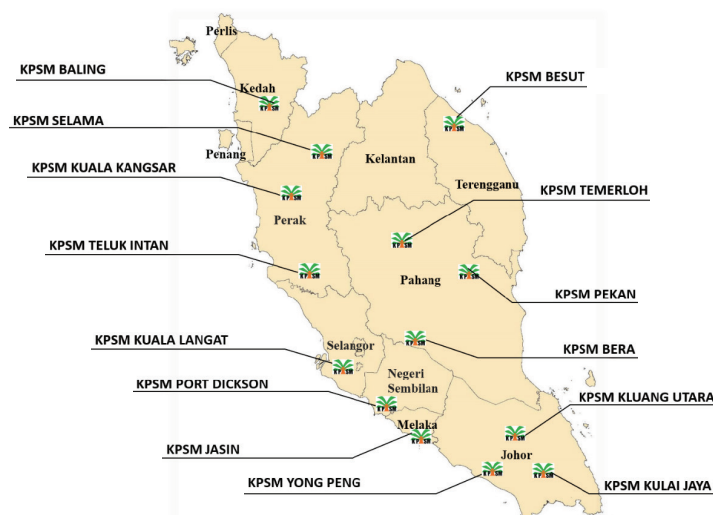


Figure 9. Study area and distribution of Sustainable Oil Palm Grower Cooperative (KPSM) in Peninsular Malaysia.

progress of each KPSM within the stipulated time was monitored and recorded daily along with other responses and feedback. After the pilot study, assessments using a survey questionnaire were conducted on all KPSMs to gather their feedback on the usage of the KIPS system. Alongside, the data collection was supplemented by secondary data from related agencies mainly from MPOB. Descriptive statistics are used to analyse and describe the data.

RESULTS AND DISCUSSION

An early assessment among 31 KPSMs in Peninsular Malaysia, Sabah and Sarawak reported 10 different models of weighbridge with different weighing software used by KPSM which translates to 32% variability in the type of system used (Figure 10). This shows the sheer amount of variability among the weighbridge system in Malaysia. Therefore, integrating directly with all the different weighing software and hardware for seamless transactions might require a different approach in the future.

Further assessment and evaluation were carried out on five of the KPSMs in Peninsular Malaysia which have a different model of the weighbridge system. Four of the KPSMs with different models can generate reports in spreadsheet files (excel or csv). However, the data generated are basic and contain different report formats across the different models (Table 2). 80% of the KPSMs are not aware that their existing system was able to generate reports therefore they are not fully utilising this function.

Table 3 describes the demographics of the respondents among the 14 KPSMs. A relatively large proportion of the 14 respondents were male (71.4%), aged between 31 and 40 years old (64.3%) and have experience in managing weighbridge operations

between 2 and 4 years (57.1%). Most of them (57.1%) reported no internet facility provided by KPSM at the weighbridge centre. Most of them (71.4%) access the internet via mobile data. This is consistent with the report from MCMC (2020) and MCMC (2021) which reported that most of the internet users in Malaysia are using mobile broadband for accessing the internet compared to fixed broadband. Therefore, the coverage of mobile data is one of the aspects that need to be investigated when introducing any technology that requires an internet connection, especially in rural areas.

Table 4 shows the practices of FFB transactions by KPSM. Most of the KPSM (57.1%) provide additional services other than selling and buying FFB such as transportation and selling of agricultural inputs. Smallholders prefer the daily price for the FFB sold (64.3%) with cash payment as their main choice (78.6%). Cash payments have been one of the ways to attract and retain smallholders to continue selling their FFB (Parthiban *et al.*, 2017a). More awareness of the benefits of cashless transactions and user-friendly systems is needed to further encourage the use of technology among smallholders especially elderly farmers (Ukoha *et al.*, 2017). KPSM representatives usually meet with smallholders during the payment for the FFB sold (85.6%).

Based on Table 5, all the KPSMs are practising record keeping of their FFB transactions with most of them (57.1%) using a computer to record. A total of 42.9% said they retain records for more than 4 years. The higher adoption of record keeping might be due to the requirement under the MPOB licensing act which requires DF to keep records of their transactions. In addition, all the records are recommended to be kept at a minimum of not less than 2 years. Lack of time has been the biggest (42.9%) constraint for record-keeping among respondents.

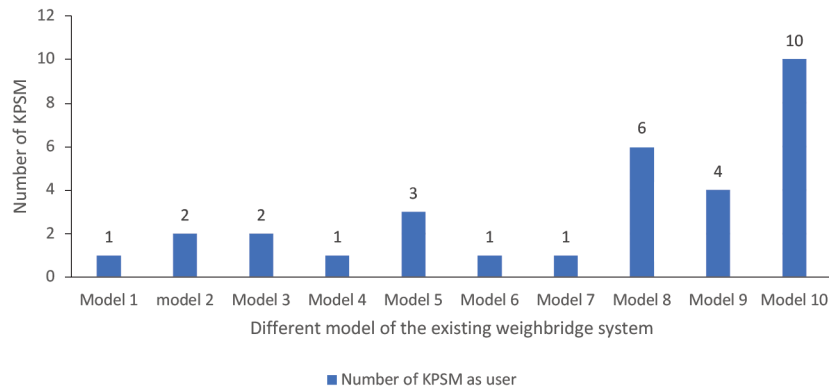


Figure 10. Number of KPSM using the different models of weighbridge system.

TABLE 2. VARIATION AMONG THE DIFFERENT MODELS OF WEIGHBRIDGE SYSTEM BASED ON PRELIMINARY ANALYSIS OF FIVE KPSM IN PENINSULAR MALAYSIA

Information/KPSM	KPSM 1	KPSM 2	KPSM 3	KPSM 4	KPSM 5
The current system can generate reports into a spreadsheet file	✓	✓	✓	✗	✓
The record generated contains basic information on the transaction (name, date, time, vehicle)	✓	✓	✓	✓	✓
The report generated contains additional information (license number, lot no, area)	✗	✗	✗	✗	✗
Existing computers have the relevant software to open and edit the spreadsheet file	✓	✓	✗	✗	✓
KPSM is aware of and utilizes the report generated from the existing weighbridge system	✗	✗	✗	✗	✓

Indication: ✓- Yes, ✗- No

TABLE 3. SOCIO-DEMOGRAPHIC PROFILE OF RESPONDENTS

Characteristics	Category	Frequency (n)	Percentage (%)	Average
Gender	Male	10	71.4	
	Female	4	28.6	
Age (yr)	≤30	3	21.4	34.1
	31-40	9	64.3	
	>40	2	14.3	
Experience in weighbridge operation (yr)	2-4	8	57.1	4.4
	5-7	5	35.7	
	8-10	1	7.2	
Internet facility provided by KPSM	Yes	6	42.9	
	No	8	57.1	
Access to internet	Broadband	4	28.6	
	Mobile data	10	71.4	

TABLE 4. PRACTICES OF FFB TRANSACTION

Characteristics	Category	Frequency (n)	Percentage (%)
Provide additional services other than buying and selling FFB	Yes	8	57.1
	No	6	42.9
The main method of FFB price favoured by smallholders	Daily price	9	64.3
	Monthly price	5	35.7
The main method of payment	Cash	11	78.6
	Electronic bank transfer	3	21.4
Time of meeting with smallholders	During harvesting	1	7.2
	During transportation	1	7.2
	During payment	12	85.6

TABLE 5. RECORD-KEEPING PRACTICES

Characteristics	Category	Frequency (n)	Percentage (%)
Practice record keeping	Yes	14	100.0
	No	0	0.0
The main method of record keeping	Book / paper	6	42.9
	Computer	8	57.1
Period for retaining records (yr)	1-2	5	35.7
	3-4	3	21.4
	> 4	6	42.9
The main constraint in record keeping	Lack of training	5	35.7
	Time constraint	6	42.9
	Forget to record	3	21.4

Table 6 shows the practices of the KIPS system among respondents during the pilot project. Most of the respondents (78.6%) used the computer to access the KIPS system. Most of them (71.4%) upload the transaction data into the KIPS the following day when the weighbridge reopens. Lack of time and resources (57.1%) emerges as the main problem in using the KIPS system. Based on the feedback from respondents, this might be due to the extra workload during the pilot project to upload data into the KIPS while continue maintaining their existing records.

Table 7 shows the overview of KIPS transactions conducted during the pilot project between November and December 2021 (2 months) by 14 KPSM. The daily average of FFB transactions is 54

tonnes per day involving an average of 42 customers with 61 ha per day. Overall, the total value of FFB transactions for two months is RM3.4 million with an average transaction value of RM246 310 for each KPSM. The daily average FFB purchase value is RM56 530. The sheer number of transactions requires a digital platform to make use of the huge data effectively.

Figure 11 shows the response received from KPSM on the report submission during the pilot project for two months. The progress of report submission using KIPS by each KPSM was recorded daily. Additionally, the response from each KPSM if they do not have any transaction on a particular day or if it is closed for a holiday or any other reason

TABLE 6. PRACTICES OF THE KIPS SYSTEM

Characteristics	Category	Frequency (n)	Percentage (%)
The main device used for accessing KIPS	Computer	11	78.6
	Smartphone	3	21.4
The time when data is uploaded into KIPS	The following day when the weighbridge reopens	10	71.4
	When back home	3	21.4
	Right after a business hour during the day	1	7.2
The main problem in using KIPS	Lack of time and resources	8	57.1
	Poor internet connection	4	28.6
	Others	2	14.3

TABLE 7. OVERVIEW OF KIPS TRANSACTION BY KPSM DURING THE 2 MONTHS PILOT PROJECT

Item	Total	Daily average	Average based on KPSM
Fresh fruit bunch (FFB) (t)	3 308	54	236
Number of customers	2 536	42	181
Hectarage (ha)	3 743	61	267
FFB purchase value (RM)	3 448 341	56 530	246 310

was also recorded. Based on this, an average of 72% of KPSM were able to submit their report through KIPS or at least able to give responses on the status of their report submission. It is assumed that the lack of commitment among certain KPSMs might be due to the voluntary basis of this project as well as a lack of time and resources.

KPSM are required to upload their daily FFB transaction before 3 pm the next day into the KIPS portal. The data entry progress of each KPSM within the stipulated time was monitored and recorded daily. 37% of KPSM were able to send their report through KIPS within the stipulated time of 3 pm the next day in November while this figure slightly increased to 44% in December (Figure 12). On average, 41% of KPSM were able to send their reports within the stipulated time between November and December. Only a small percentage of 14% and 8% of KPSM were not able to adhere to the given time respectively in November and December. Continued engagement to remind KPSM to send their reports within the time limit is important to create awareness during the early stage of implementation. An automated reminder within the KIPS system might be an extra improvement that can be considered in the future.

The acceptance of KIPS among KPSM has been divided based on usefulness, ease of use, attitude

to use and behavioural intention with a 5-point Likert scale with 5 being the most agreed (Table 8). KPSM scored neutral on the usefulness of KIPS 3.29, especially on time, performance and productivity. This might be due to the extra workload during the pilot project to upload data into the KIPS while continue maintaining their existing records. KPSM generally agree that KIPS is easy to use with a score of 4.01. However, since this pilot project is conducted voluntarily, the extra workload to use KIPS has slightly hindered their attitude and behavioural intention to use KIPS with a score of 3.42 and 3.49 respectively. Mandatory usage might be important in influencing initial adoption among users while voluntary usage is mainly influenced by the personal relevance of the system (Agarwal *et al.*, 1997; Hartwick *et al.*, 1994). Other than that, cultural willingness to move beyond traditional methods has influenced technology adoption among organisations (Hossain *et al.*, 2015).

CONCLUSION

KIPS system was developed using a three-tier architecture and contains three user modules of admin, dealer fruit and smallholder with different

TABLE 8. ACCEPTANCE OF KIPS AMONG KPSM

Item	Statement	Frequency					Mean	SDv
		SD	D	N	A	SA		
1.0	Usefulness of KIPS	Mean: 3.29						
1.1	KIPS helps to keep records more systematically than manual methods	0	1	4	9	0	3.57	0.6
1.2	KIPS helps in retrieving transaction data faster than manual methods	0	2	4	8	0	3.43	0.8
1.2	KIPS reduces the time needed for recording compared to manual methods	0	3	6	5	0	3.14	0.8
1.4	KIPS able to increase performance for record-keeping practice	0	3	6	5	0	3.14	0.8
1.5	KIPS can increase productivity in record keeping	0	3	6	5	0	3.14	0.8
2.0	Ease of use of KIPS	Mean: 4.01						
2.1	KIPS is easy to use	0	0	5	4	5	4.00	0.9
2.2	The menu in KIPS is clear and easy to understand	0	0	2	5	7	4.36	0.7
2.3	KIPS is easy to learn	0	0	5	6	3	3.86	0.8
2.4	It's easy to become skilled in using KIPS	0	0	6	8	0	3.57	0.5
2.5	It's easy to retrieve information from KIPS	0	0	3	5	6	4.21	0.8
2.6	The procedure for data entry is fast and easy	0	0	5	6	3	3.86	0.8
2.7	I have the skills to use KIPS	0	0	3	5	6	4.21	0.8
3.0	Attitude towards using KIPS	Mean: 3.42						
3.1	KIPS can overcome the problem of selling FFB without a license/theft	0	1	5	8	0	3.50	0.7
3.2	The use of KIPS for traceability is important for the palm oil industry, especially the weighbridge centre	0	0	3	3	8	4.36	0.8
3.3	The use of KIPS to record FFB transactions is a good idea	0	1	3	9	1	3.71	0.7
3.4	Satisfied with using KIPS to record FFB transaction	0	3	7	4	0	3.07	0.7
3.5	KIPS can help in record-keeping practices	0	0	4	10	0	3.71	0.5
3.6	KIPS reduces the workload among dealers	7	0	5	2	0	2.14	1.2
4.0	Behavioural Intention to use KIPS	Mean:3.49						
4.1	More frequent use of KIPS for record-keeping	0	7	2	4	1	2.93	1.1
4.2	Continue the use of KIPS throughout operating the weighbridge centre	0	7	2	4	1	2.93	1.1
4.3	The cost of using KIPS will be an important factor in deciding on the use of KIPS in future	0	2	5	5	2	3.50	0.9
4.4	Comprehensive use of KIPS by all the weighbridge centres is important in deciding on the use of KIPS in future	0	0	2	7	5	4.21	0.7
4.5	The use of KIPS should be made mandatory by the authority to all weighbridge centres in ensuring transparency in FFB transaction	1	3	6	4	0	2.93	0.9
4.6	Lack of complete enforcement in the use of KIPS will result in customers migrating to other weighbridge centres to avoid detection.	0	0	1	6	7	4.43	0.6

Note: KIPS - *Kebolehejekan Informasi Pekebun Kecil Sawit*; FFB - fresh fruit bunch; SDv - standard deviation.

Likert scale interpretation: 1.00-1.80=Strongly disagree (SD), 1.81-2.60=Disagree(D), 2.61-3.40 =Neutral(N), 3.41-4.20=Agree(A), 4.21-5.00= Strongly Agree(SA).

levels of access. Data entry modules were developed either as individual data entries for each transaction or as a group upload using Comma Separated Values (CSV) format. Non-variable information is synchronised automatically by the system to

generate relevant reports. Overall movements of FFB from farm to DF to the mill can be viewed on a map based on OpenStreetMap®. Overall, most of the KPSM were able to submit their report through KIPS within the stipulated period. KPSM generally

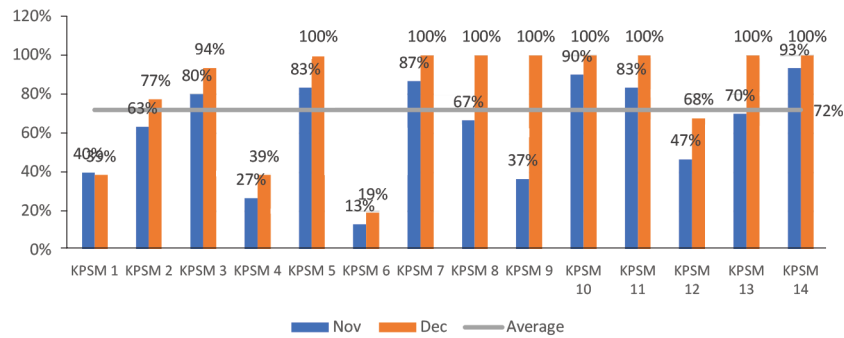


Figure 11. Progress of response on report submission by KPSM during the pilot project.

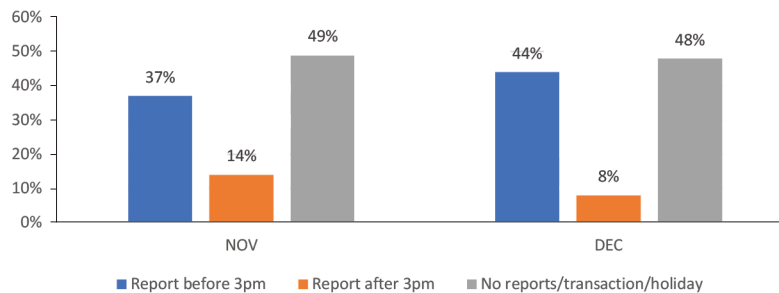


Figure 12. Progress of reporting using KIPS among KPSM within the stipulated time.

agree that the KIPS portal as being easy to use with a clear menu and easy to understand and learn. However, their attitude and behavioural intention to continue using the KIPS is slightly low given the high workload, lack of resources and voluntary basis of the implementation. Coverage of mobile data is one of the aspects that need to be looked into when introducing any technology that requires an internet connection, especially in rural areas. Government's intervention to make mandatory the use of a traceability system among industry players might be an important factor in influencing initial adoption. Other than that, changes in cultural willingness to make the transition from traditional methods to adopting new technology are important to increase the adoption level.

LIMITATIONS OF THE STUDY

One of the limitations of this study includes the generalisability of the findings due to the nature of the case study. In this study, the respondents are chosen only from the Sustainable Oil Palm Grower Cooperative (KPSM) which might not represent all the dealers as a whole, especially the private individual dealers. During the pilot project, the extra workload to use KIPS while continuously using the conventional method for record-keeping might have introduced some bias in the response among KPSM.

RECOMMENDATION

The developed pilot system and the findings of this study can serve as a basic framework for the development of a more comprehensive traceability system. It provides an opportunity for the industry to address the current gap in traceability among oil palm smallholders and dealers via technology. It was also able to provide analytical information to help in decision-making for an effective enforcement activity to minimise the problem of unauthorised use of smallholder's licenses or sales made without a license in the industry. In the future, a more comprehensive traceability system can be developed based on this study to further optimise the flow of information by linking dealers and smallholders through a two-way communication to include services such as harvesting, transportation and payment transfer. Further initiates to integrate information flow from end-to-end supply chain right from production until the end-user would provide a comprehensive palm oil traceability. Harmonisation between different readily available platforms across the different organisations for the palm oil supply chain should be proposed. Government policy and regulatory requirements should liaise with the main objective of bringing different organisations together for the common benefit of the industry. The application of blockchain technology needs to be intensified in palm oil supply chain management

together with sustainability certifications such as MSPO, RSPO and others. Incorporating all the data on the supply chain using technology such as blockchain, the IoT and physical supply chains such as robots, sensors and drones will further elevate the traceability of the Malaysian palm oil industry.

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