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FARM AUTOMATION IN PADDY PLANTATION: CASE OF KEDAH

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Abstract:

Today's paddy cultivation is more advanced and efficient than in the past. Various advanced technologies used by paddy operators to ensure the paddy plantation process become efficient and provide high quality. The purpose of this study was to investigate the application of current technology in paddy plantation and explore the management of drones in paddy plantations in Kedah. In this sense, a 9,425 km^2 region surrounding Kedah was chosen as the study area. Kedah is among the states with the most paddy crops in Malaysia. The questionnaire was distributed among the farmers in Kedah to gather statistics and information on how they manage their paddy plantation. In gathering correct information about the use of drone technology and the energy required for rice farming, drone service providers were also contacted and interviewed. The results of this study demonstrated that the process of planting rice involves highly automated technologies. It also revealed that farmers in Kedah were using mechanisation technology effectively. The government should make aggressive efforts to improve the role of mechanised technology to assist in achieving the nation's rice supply targets.

Keywords:

Farm Automation, Energy Consumption, Paddy Plantation, Malaysia

Introduction

Penetration of technology in the agriculture sector helps to increase the production output. Farm automation can be characterized as a sort of innovation that makes strides agriculture effectiveness by automating the trim or animals generation cycle. It makes utilize of rural

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agriculture machinery, chemical sensors, computer frameworks, hardware, and information administration to decrease the require for human work in gear operation and decision-making. The nearness of cultivate mechanization frameworks could be an alluring advancement. The advances utilized for cultivate robotization like collect mechanization, independent tractors, drones, and seeding and weeding are ordinarily connected within the agriculture sector (Top 10 Fieldking Farm Equipment 2022 – Types and Features, 2020). Specialized bolster for agribusiness has been broad and has presently come to the arrange of keen agribusiness with profound learning, the Internet of Things, remote sensor systems, and mechanization of agricultural processes (Murugaraj, Kumar, Pillai, & Bharatiraja, 2022).

Nowadays, paddy farming is growing increasingly prevalent throughout the Malaysian culture, particularly in the state of Kedah. Parallel to these, the government's continued efforts to support the agricultural sector can be seen in every Malaysian plan that mentions aid to provide a large portion of the budget for the agricultural sector (Adnan, Nordin, & Anwar, 2020). When compared to other states, the community in the state is one of those with a sizable area of rice cultivation land. Figure 1 indicates the paddy field areas in Malaysia. In addition to the granary areas, there are 74 other secondary granaries and 172 other granaries in Malaysia with a total area of 28,441 and 47,653 hectares, respectively (Rahmat, Firdaus, Shaharudin, & Ling, 2019).

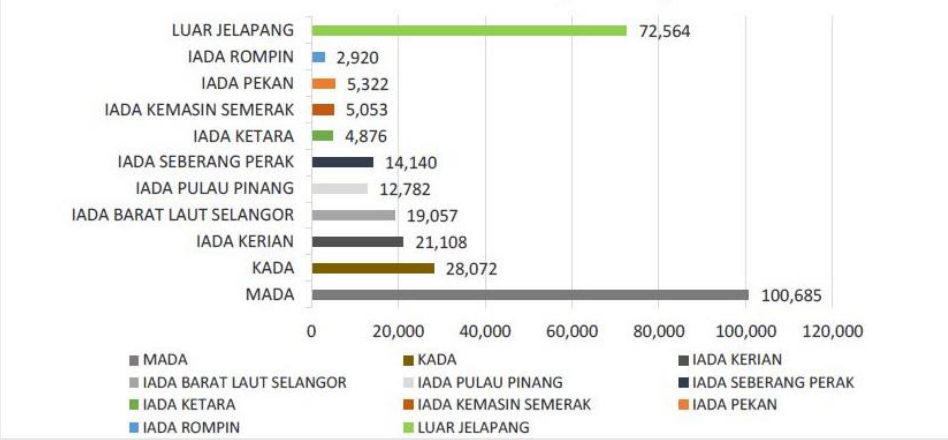

Figure 1: Paddy Field Areas in Malaysia (Hectares)

Energy management is the method of checking and altering vitality utilize so that facility can utilize less vitality without rotting the yield quality. A change in farmer practices is needed to rapidly adopt new technologies that increase yields, while also addressing environmental concerns and energy consumption (Nordin, et al., 2022). The method of managing energy comprises of the taking after steps: gathering and studying progressing information to extend vitality proficiency, recognize changes to hardware plans, and set focuses and stream rates. In addition to reducing carbon emissions, energy management aims to meet legal requirements and organisational sustainability goals. In relation to this, energy management and optimisation technologies can increase mill efficiency and reduce cost. The agriculture industry employments vitality straightforwardly on the cultivate within the shape of fuel or power to control apparatus and gear, warm or cool buildings, and light, and by implication within the shape of composts and chemicals created off the cultivate. This makes energy management and optimisation crucial in every aspect (Schnepf, 2020).

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Many new technologies have now been revealed. As many individuals are informed, Malaysia has extensively used smart technology for building, architecture, and particularly for planting reasons like paddy plantation. These days, the application of drone is developing at a quick rate in agribusiness sector (Hafeez, et al., 2023). Drones are a well-known example of the technology that paddy plant managers employ to spray fertilisers, pesticides, and other things. As a result, every form of energy will be considered in this research. Mechanisation on farms for paddy production has recently gained popularity in Malaysia, particularly in soil preparation and harvesting, such as the use of the Internet of Things (IoT) (SabahKini2, 2022). In general, this study aim (1) to identify the use of technology in paddy plantation process and (2) to explore the drone consumption in paddy plantation process at Kedah.

Literature Review

Current Status on Farm Automation

As generally known, farm automation, sometimes referred to as "smart farming," is a type of technology that improves farm efficiency by automating the cycle of agricultural or livestock production. Drones, automated tractors, robotic harvesters, automated watering and seeding robots are being developed by more and more companies. namely Sanyeong Agricultural Solutions Sdn. Bhd., Aonic (formerly Poladrone), Aerodyne, etc. Braintree Technologies Sdn Bhd one of the companies that use drone to do tree tallying and showering, plantation mapping, invasion mapping, etc.; TanaLink EARS function for employments innovation to supply real-time information and checking of their cultivate for robbery, collecting, treatment scope, natural life nearness, soil sensors, etc. Although these technologies are still relatively new, more and more traditional agribusinesses are integrating agricultural automation into their operations. Paddy areas in Europe pointing at the usage of solid programmed water system frameworks which bolster the manual operations of these laborers is entirely energized particularly by ranchers in arrange to guarantee a more allotment of water within the areas concurring to edit conditions (Masseroni, et al., 2018). The intercession of progressed innovations such as sensors, microcontrollers, and program devices in farming, permit the exact utilize of the connected chemical by controlling the application rate concurring to the site-specific necessity, particularly in pest management for crop cultivation cycles (Tewari, Pareek, Lal, Dhruw, & Singh, 2020).

The farm automation technology's major purpose is to accommodate simpler and more routine chores. Farm automation is critical on a global scale to increase the quality of items produced, particularly in rice fields (Shalimov, 2020) The introduction of technological equipment, such as automatic rice harvesting machines, drones, and other similar devices, can assist to relieve the pressure on personnel, allowing them to better manage the farm. Every new paddy plantation farm automation technology is extremely complex. Using this kind of farm automation, many countries have made progress in enhancing the quality of their rice.

In Malaysia, smallholder farmers dominate the agriculture industry, which faces issues like low productivity and crop production and a lack of workforce. This business, according to numerous surveys and industry experts, is in desperate need of modernisation. Therefore, IBM Malaysia has collaborated with the Sarawak Multimedia Authority (SMA) to bring Artificial Intelligence (AI), IoT, advanced analytics, and blockchain to the agriculture industry (Yun, 2020).

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Malaysia's Paddy Plantation

Malaysia's self-sufficiency program focuses on the production of rice, the country's staple and staple food crop. Malaysia continues its proactive and progressive efforts to support the growth of the rice sector under the 11th Malaysia Plan (2016-2020) and National Agro-Food Policy (2011–2020). Rice is the main food of the people in this country. Paddy cultivation is becoming more advanced day by day and always in accordance with the current technology. Rice is the bulk of the population's basic meal. Malaysian adults consume 2.5 plates of white rice per day on average (Kasim, 2020)

Paddy harvesting has always been proven to be a difficult problem to automate. The harvester must be strong with yield to avoid damage. 'Jentuai' has successfully developed machines to harvest rice in a quality manner, no matter in large or small quantities. With such a machine, it can meet the quality standards of farmers (Shalimov, 2020).

Moreover, locally produced fragrant rice satisfies the preferences of local consumers. The cost of rice production has risen, reducing the country's competitiveness within the ASEAN region. Figure 2 shows the leading countries of milled rice production in 2020/2021. Incentives and subsidies from the government are maintained to ensure the long-term viability of rice production. The policy on food security addresses the issue of low income among farmers. The state now bears the burden of liberalisation, with issues of protection and obstacles to signing a trade liberalisation agreement with an exporting country (Omar & Tumin, 2021).

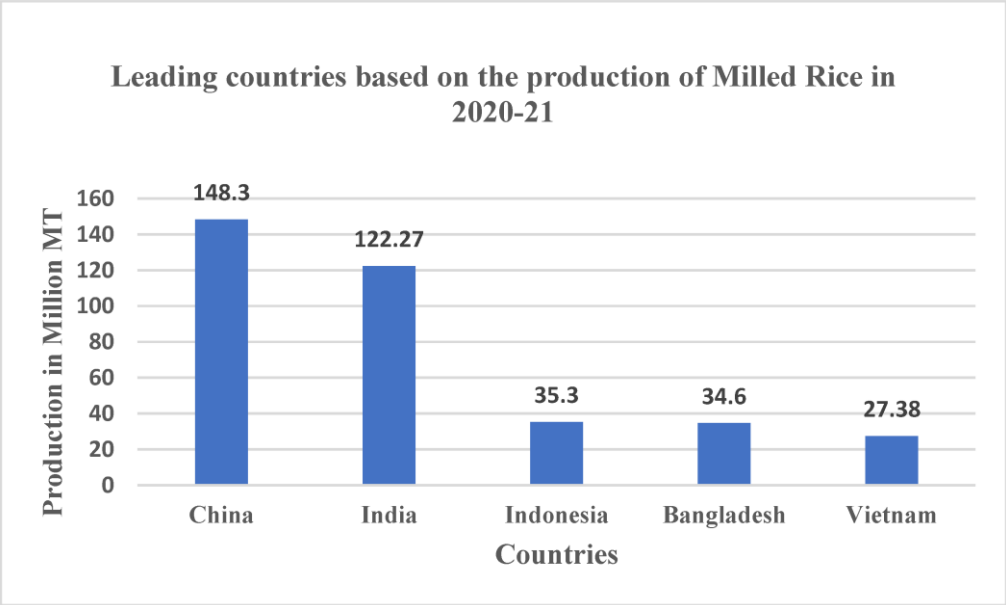

Figure 2: Top Five Rice Production

Energy Management in Paddy Plantations

Energy is a crucial productivity input for agriculture. Energy is used in agriculture both directly as fuel or electricity to run machinery for heating or cooling buildings, and for lighting on farms and indirectly as fertilisers and chemicals made off farms. Therefore, this study also wants to observe the extent of energy consumption in the rice cultivation process. Energy management in paddy fields is very important to be well-planned to avoid many problems, such as a lack of manpower, increased consumption of electricity, and more. In agriculture, energy is critical for crop production and agro-processing for added value. In agriculture, humans, animals, and

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machinery are all employed to grow crops. The amount of energy consumed is determined by the level of mechanisation, the number of active agricultural employees, and the amount of land available for cultivation. Agriculture's energy requirements are separated into two categories: direct and indirect energy usage. Various operations associated to the crop production process, such as post-harvest handling, require direct energy (Baharuddin & Arsyad, 2019). These operations include agricultural inputs gathering, land preparation, cultivation, crop management, irrigation, harvesting, and transportation.

Fuel, electricity, and manpower are the primary sources of energy on farms and ranches. Indirect energy, on the other hand, refers to the energy used in fertilisers, herbicides, seeds, and farm machinery. According to (Shafie, et al., 2023), paddy production is one of the energy-intensive production systems. Input costs will rise due to the rising international crude oil and fertiliser prices, putting pressure on farmers' income, subsidies, and incentives.

Paddy production in the MADA area, for example, necessitates energy at all stages of production, including both direct and indirect energy usage. Land preparation (tillage and land levelling), planting (direct seeding and transplanting machines), crop management (adding fertilisers, spraying pesticides), harvesting, and post-harvest are the five key tasks involved in paddy production. The threshing procedure is not included in paddy cultivation in the MADA area, as it is conducted in the rice mill. Direct seeding – spreading pre-germinated rice seeds straight into the field manually using a row seeder – or transplanting – which starts with putting 25 until 35-day seedlings into the main field by hand (human labour) or machine (transplanter) using seedlings sown on trays. Paddy machinery uses direct energy in the form of diesel and gasoline. Meanwhile, indirect energy use is mostly driven by the manufacturing and use of fertilisers, herbicides, and seeds, all of which are required to boost agricultural yields (Baharuddin & Arsyad, 2019).

Humans, fuel, machinery, seeds, fertilisers, and pesticides are all key sources of energy for rice production in Malaysia's wetland paddy cultivation. In addition, the quantity of energy input (direct and indirect) utilised in rice farming determines how much energy is consumed when reading an article. Fertilisers, insecticides, and seeds are examples of indirect energy usage. Energy management in Malaysia's plantation automation is increasingly advanced. This is because the use of high-quality fertilizers and the use of drones are also done in Malaysia to obtain high quality rice. Energy management in paddy cultivation is very important for paddy harvesters to anticipate and manage every energy out of them wisely (Baharuddin & Arsyad, 2019).

Overall, farm automation in paddy plantations is a very efficient paddy land management by using various new technologies that are applied in the paddy plantation. The presence of this cutting-edge technology aids in the facilitation of operations formerly handled by machines. Institutions, on the other hand, play a critical role in maintaining the demand and supply for the product development of straws. Participation and support from cooperation officers, promotions, expert help, and management efficiency must be mobilised.

The advantages of this technology are enormous, providing more space and opportunity for many parties, but promotions and strong backing from superiors must continue. Promotion is critical in informing the community, particularly farmers, about the importance and benefits of using straw products for economic development and environmental protection. For example,

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consumers, particularly farmers, are unaware of the importance of organic inputs in increasing soil and crop fertility, as well as higher output yields over time. Figure 3 shows the energy consumption in rice cultivation in Kedah.

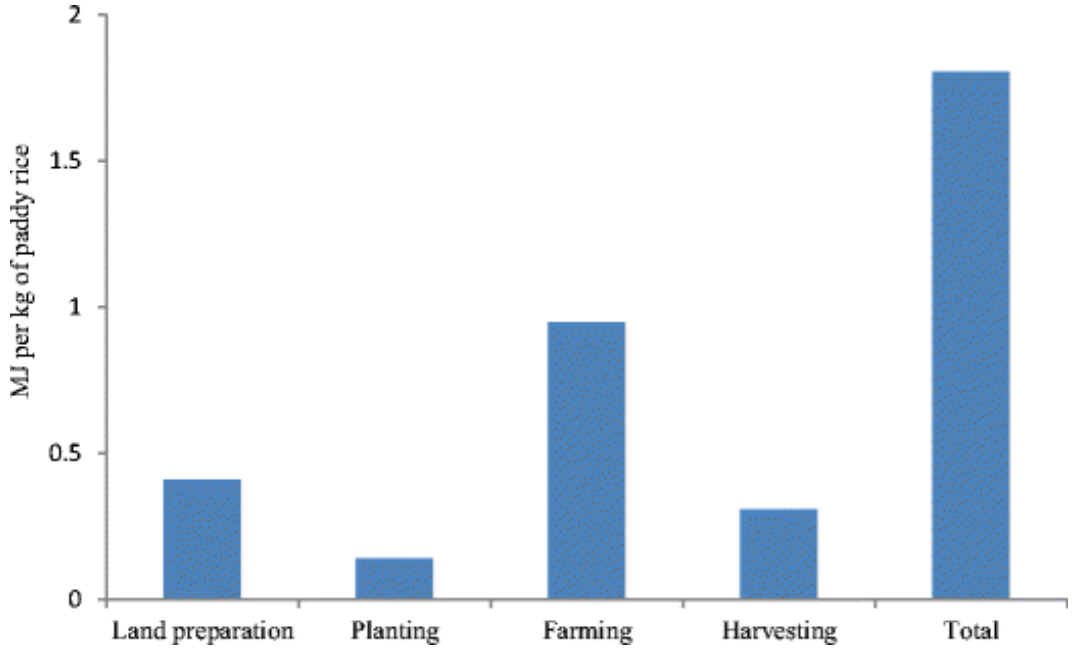

Figure 3: Energy Use in Rice Cultivation

Methodology

This study used two approaches, i.e., quantitative and qualitative methods. Using both qualitative and quantitative methods have a positive influence on the outcomes of the study pursued. The quantitative method is used to examine the level of farm automation in paddy fields to farmers, and to find out the extent to which they use technology, such as drones, in their rice cultivation process. This method was conducted in the form of a survey. The findings of the study were collected through the survey. This quantitative method used the Statistical Package for the Social Sciences (SPSS) to analyse the data. The data used were in the form of descriptive analysis, which was to calculate the mean for the usage level of drone technology by rice farmers. On the other hand, the qualitative method was used to determine the level of energy management in paddy fields against farm atomisation. This method was carried out via interviews with two service providers (drone) to obtain more in-depth study results on the research objectives. This research process was also followed by a flow chart diagram as below.

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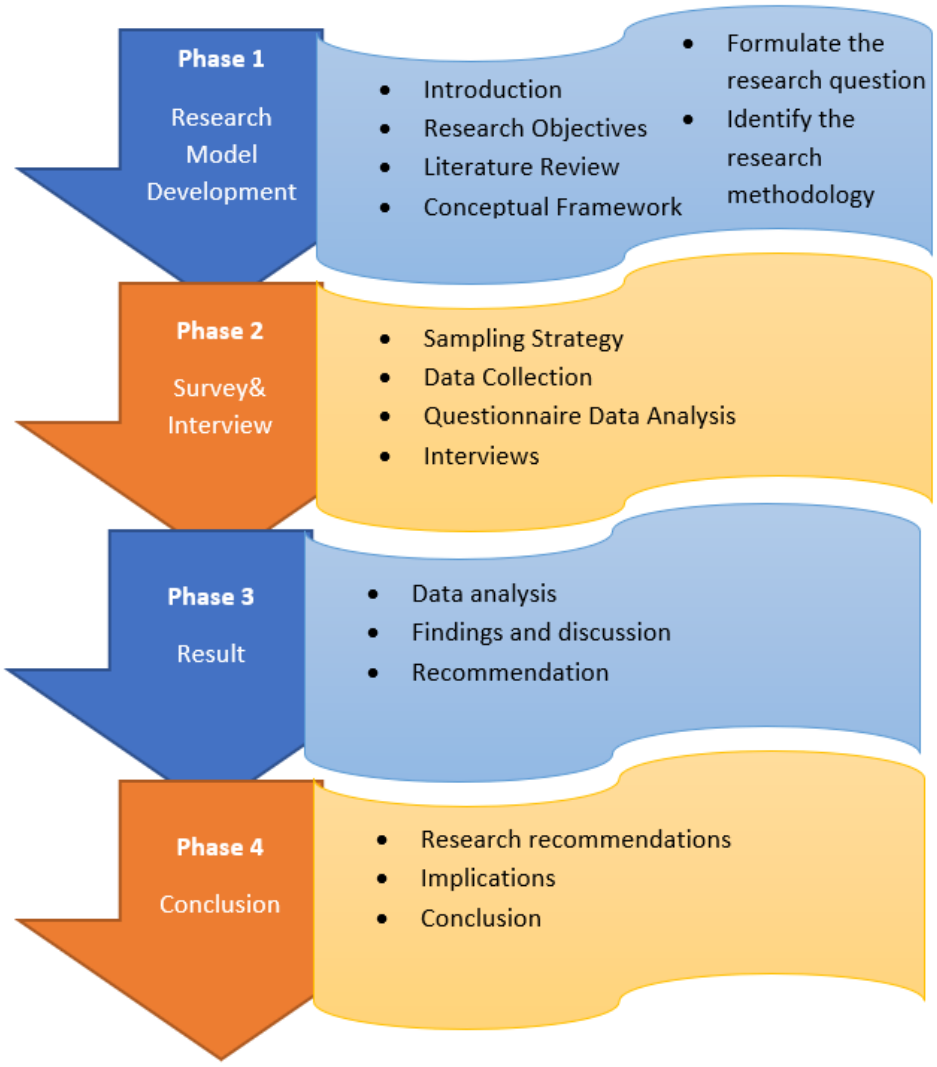

Figure 4: Flow Chart of the Research Design

Quantitative

A set of questionnaires with three sections was used in order to determine the current adoption of automation in paddy plantations in Kedah. A simple answering session of the questionnaire through telephone was conducted with 27 District Farmers' Organisation (DPO) Managers in MADA areas to access the database of farmers under their area. As a result, only two zones were considered to distribute the survey to the farmers. The zones involved in this study were Zone II (Jitra) and Zone IV (Pendang). Sample survey questions were distributed via the WhatsApp application and Google Forms. Survey questions were distributed to contacts who were registered under MADA's District Farmers' Organisation (DFO). Many of them were between 40 and 60 years old. The difficulty in collecting this survey data was that some of them were not familiar with the use of telephones. The results of the survey found that 30 samples were filled out by the respondents. Although relatively little, it is very helpful in the data collection process to achieve the first objective of this study.

Qualitative

The qualitative method was used to inquire the level of energy management in paddy fields against farm atomisation. This method was performed via interviews with two service

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providers (drone) to obtain more in-depth study results on the objectives studied. The two companies were Sanyeong Agricultural Solutions Sdn. Bhd. and Aonic (formerly Poladrone). These two companies provided different drone services, Aonic also sold drones from Sanyeong Agricultural. Throughout the interview, the conversation was recorded through a voice recorder.

Results

Quantitative

In this quantitative method, the use of technology in rice crops were able to be determined. Many respondents who answered this survey used technology in their crop cultivation. Therefore, the result on which rice cultivation process most often uses technology would become clearer.

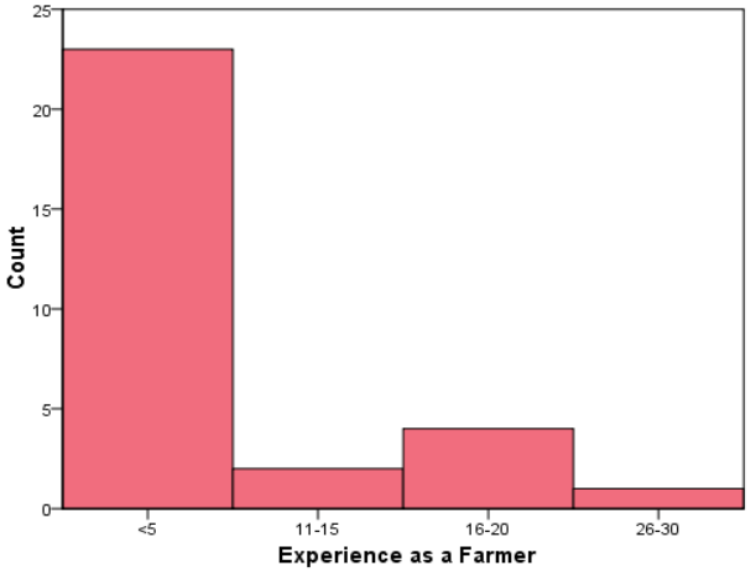

Figure 5: Experience as a Farmer

As in Figure 5 above, farmers with less than five years of experience answered the survey question the most. This result was followed by farmers with experience of 16–20 years, 11–15 years, and the least with experience of 26–30 years.

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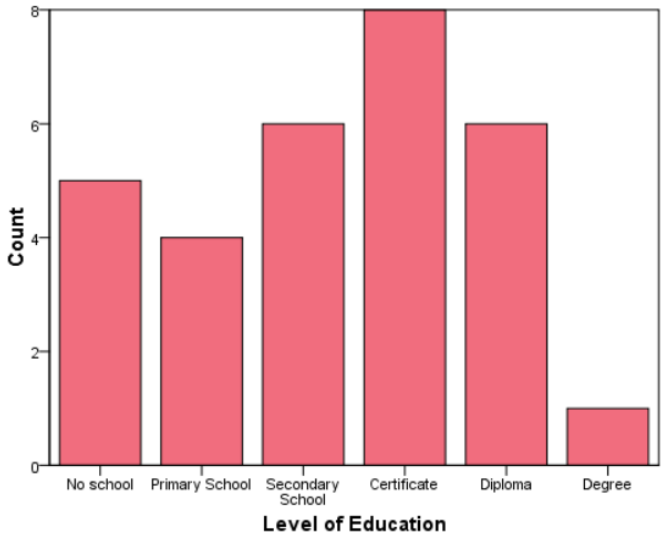

Figure 6: Level of Education

For the level of education, farmers who had obtained a certificate were among the most respondents who filled out the survey questions for this study. This result was followed by farmers who had a high school education level, Diploma, no schooling, and primary school. The least respondents held a Bachelor's degree. 50% of the participants at least had a certificate as their education level.

Descriptive Analysis

In the descriptive analysis, mean and standard deviation for interval scaling variables were obtained. Independent variables included the level of automation in rice farms, while the level of technology acceptance in rice cultivation was considered as a dependent variable. Descriptive statistics for the final list of the study variables are shown in Table 1.

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
1. Using technology in determining the rate or number of seeds required for the rice planting process.	30	1	4	1.27	0.691
2. Using technology in seed preparation for the rice paddy planting process.	30	1	4	1.37	0.718
3. Using technology in the land ploughing process on the paddy fields.	30	1	4	1.20	0.610
4. Using technology in water management throughout the rice planting process.	30	1	4	1.10	0.548
5. Using technology in the weed and pest management process on paddy rice plants.	30	1	4	1.27	0.691

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6. Using technology in the rice planting process/ seed spraying for the rice paddy planting process.	30	1	4	1.13	0.571
7. Do you use drones in insect and pest management?	30	1	2	1.33	0.479

Table 2 presents a frequency analysis of farmers using drones in insect and pest management. The results showed that many people used drones in insect and pest management. There might be a positive effect on the development of technology in rice cultivation.

Table 2: Frequency of Using Drones in Insect and Pest Management

		Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Valid	Yes	20	66.7%	66.7%	66.7%
	No	10	33.3%	33.3%	100.0%
	Total	30	100.0%	100.0%	

Table 3 depicts an analysis of the frequency of farmers using technology in the rice planting process or seed spraying for the rice planting process. Based on the results, many farmers used technology in the rice planting or seed spraying process. This result proved that the use of technology in rice farming in Kedah illustrated a more advanced direction in line with the current era.

Table 3: Frequency of Farmers Using Technology in the Rice Planting or Seed Spraying Process

		Frequency	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Valid	Used a lot	28	93.3%	93.3%	93.3%
	Rarely used	1	3.3%	3.3%	96.7%
	Moderate	1	3.3%	3.3%	100.0%
	Total	30	100.0%	100.0%	

Table 4 illustrates the analysis of the frequency of farmers using drones in insect and pest management. The results showed that many farmers in Kedah used drones in insect and pest management. This outcome proved that the use of drones in rice farming in Kedah had been expanded to save time and manpower.

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	No	10	33.3%	33.3%	100.0%
	Total	30	100.0%	100.0%	

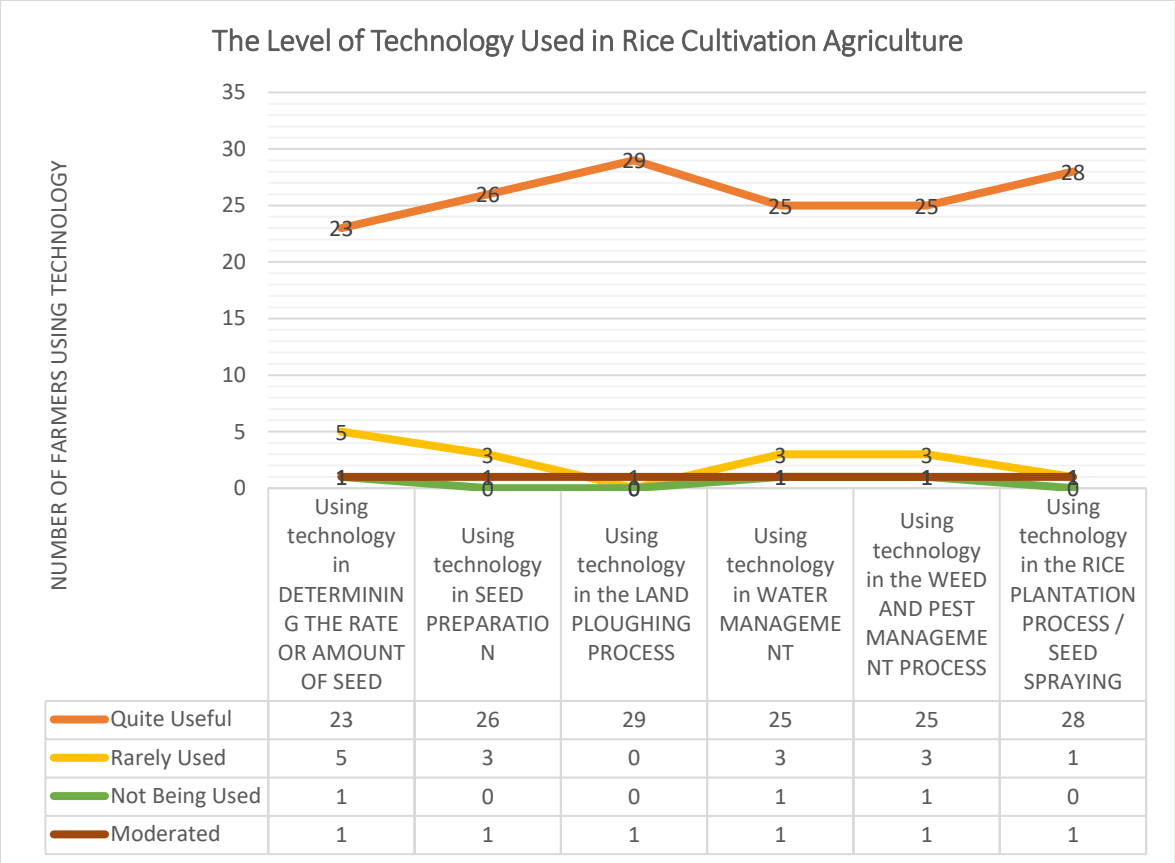

Figure 7: Level of Technology Used in Rice Cultivation Agriculture

The results obtained from this quantitative method showed that the use of technology in rice farming was increasingly positive and accepted by many farmers, especially in the state of Kedah. This outcome was proven by all the data collected through the distributed survey questions. Then, the data were run through SPSS to identify the mean and standard deviation according to important questions in line with the first objective of this study.

Based on the results obtained, 29 out of 30 farmers (i.e., 96.7%) used technology in water management throughout the rice planting process. Another 3.3% was represented by a farmer who did not use technology in water management. It is clear that the use of technology in water management is among the most used by farmers in Kedah. This result was followed by using technology in the process of planting rice/seed spraying, which was a total of 28 respondents,

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i.e., 93.3%. One respondent rarely used technology as well as the other respondent indicated that he used technology moderately. Apart from that, the level of technology used, such as in the process of ploughing the land in the paddy fields, in the process of managing weeds and pests on the rice plants, in determining the rate or number of seeds required for the rice planting process as well as in the preparation of seeds for the rice planting process, showed that the data were still ahead of others.

Qualitative

According to Bhandari, 2020, non-numerical data (such as text, video, or audio) in qualitative research are gathered and analysed to better comprehend ideas, opinions, or experiences. It can be used to discover intricate details about a situation or to come up with fresh research concepts. This study conducted online interviews to identify energy management in drone technology in the agricultural process of rice cultivation. This qualitative method was used in this study to unearth and obtain information about the use of energy in drone technology.

This study conducted online interviews with two people from two different drone service providers. A Chief Operating Officer (COO) from DJI Agriculture Malaysia Sanyeong was interviewed via voice call. While another person from Aonic (formerly Poladrone) who held the position of Sales Executive Marketing was also interviewed by voice call. They were in their 40s and had three years of experience in the industry. The two companies supplied various types of drones for the agriculture sector. The results of the interview found that the use of drones by rice farmers was very large. The main purpose of interviewing them was to obtain information about energy use and energy management in rice cultivation to complete the second objective of this study. Table 5 below shows the demographic data of the interviewees from two different companies.

Table 5: Data Information of Interviewees

Detail	**DJI Agriculture Malaysia Sanyeong**	**Aonic (formerly Poladrone)**
Company Address	Lot 2973, Batu 8 3/4, Jalan Datuk Kumbar, Kampung Padang, Mukim Tajar, 06500 Langgar, Kedah.	Poladrone - L1-Futurise Center, Persiaran Apec, Cyber 8, 63000 Cyberjaya, Selangor.
Position	Chief Operating Officer (COO), DJI Agriculture Malaysia Sanyeong	Sales Executive Marketing, Aonic
Work Experience	3 years	3 years

Discussion

In completing the first objective, many survey questions were distributed to all rice farmers in Kedah through WhatsApp groups and face-to-face. A total of 30 people answered the survey questions, and the results were also identified. The use of technology in rice farming was evident by today's farmers to facilitate their farming process. With the results obtained, there is a positive effect in the use of technology in the automation of rice plants, especially in Kedah.

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As for completing the second objective in this study, the interview results found that energy consumption by drone technology in two different companies showed that their drones had many senses in energy management. The energy used was also the same, which was to use batteries to operate in rice cultivation activities for a certain period. The interviewees responded that energy management for drone technology is very easy to manage in several ways for each company itself. The main themes associated with this internal element were energy management and the type of energy used for the drone. The respondents were referred to as R1 and R2 to facilitate differences and similarities to obtain clearer results. Information was obtained through semi-structured interviews, as well as observations of how they manage energy.

Type of Energy Used

For this agricultural drone technology, especially for rice farming, the drones from these two companies were very sophisticated and their level of effectiveness was also high. The life cycle of the drone itself depended on the battery being charged. Battery life was dependent on how many times the drone operated. These two companies had similarities in terms of battery energy consumption and battery life, which was also almost the same. Both said the same thing about the energy consumption, i.e., the battery energy used in the drone. As in the dialogue below, both have stated about the energy consumption by drones from their respective companies.

R1: "…*For our drones, everything uses battery power so far. Because the drones we supply are the latest and most advanced drones, such as the T20P model*."

R2: "…*Our drones have many models. For the Oryctes model, this model is naturally the top one in our company, which has a high demand by rice plant operators. For the lifespan of this battery, it has a power battery of 22000 mAh, 12S LiPo*."

The responses showed that the use of battery energy was very effective for drones to operate in rice farming. Drones from these two companies were proven to use batteries to continue operating.

Management of the Energy Used

For the management of the energy used, the two companies that were interviewed had their own methods, as stated in the dialogue below:

R1: "…*battery optimisation is done intelligently by the drone system with available features*."

R2: "…*Our drone has a smart system that can limit the battery for energy saving*."

The above statements can conclude that the energy management applied by them was quite the same, but the possibility that the system they used to manage the energy was slightly different. The table below shows the differences and similarities in energy consumption and energy management used for the two companies.

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Table 6: Comparison on the Usage of Energy Consumption and Energy Management

Comparison Usage of Energy Consumption		Comparison of Energy Management
DJI Agriculture Malaysia Sanyeong	Battery usage - Model: T20P From 75% - 60% = 15%. 15% of 13,000mAh = 1,950mAh	Battery optimisation is done intelligently by the drone system with the available features.
Aonic (formerly Poladrone)	Battery usage - Model: Oryctes Power of Battery = 22,000mAh	Has a smart system that can limit the battery for energy saving

The results obtained in this second objective can conclude that the use of battery energy is very convenient for the users of drones. The capacity of the drone also showed that it could operate until the agricultural work process was completed. As an example of the process of spraying caterpillar poison and fertilisers, with the capacity of the battery, the spraying operation could be completed by the drone evenly in a duration of 30 minutes. As for the energy management results, these two companies had a smart system to optimise the battery energy used to save the use of the battery.

Overall, the use of energy and energy management in drone agriculture technology had been well managed by the two companies. The results of the study found that the two companies successfully supplied such drones to rice plant operators to facilitate their agricultural activities. With the drones, farmers can save money, energy, and time.

Conclusion

In conclusion, the findings of the study showed that farmers, especially in Kedah, responded better to the adoption of automation technology. Farmers who grow rice use technology in agriculture extensively. Researchers must also have an impact on the use of these farm automation technology tools. For farmers who use mechanised technology in the agricultural sector, especially the rice industry, the impact of external influences is very important. This study benefits farmers because it can improve their understanding of using agricultural technology and help them manage expenses and energy more effectively. In addition, it is expected that the growing use of technology in rice farming automation by farmers will increase government support and encouragement. The rice industry is known to use significant mechanised agro technology. In helping meet domestic rice supply goals, the government and related agencies can improve the technology functions in farm automation.

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