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DEVELOPMENT OF INTEGRATED PEST MANAGEMENT "PEROSAK & PENYAKIT" APP WITH ECONOMIC THRESHOLD AND PESTICIDE MODE OF ACTION TO ASSIST MALAYSIAN RICE FARMER DECISION MAKING

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ABSTRACT

The Integrated Pest Management (IPM) is a globally recognize sustainable approach for pest management in farm. The IPM integrates regular pest monitoring, cultural and biological controls, and prudent pesticide use at Economic Threshold Levels (ETL). In management of rice pest, various factors such as type of pest, suitable control methods and types of pesticides are sometimes become too much for farmer's process. The use of mobile application (app) could help the farmer for making decision. However, local farmers encounter barriers accessing Malay language smartphone apps offering IPM-based information on rice pest and disease management. Thus, this study sought to develop an app providing such information in Malay, based on IPM approaches. A database was compiled with details on managing 18 rice pests and 14 diseases, including basic information, symptom descriptions with relevant photos, and IPM-based control methods. In November 2020, an Android prototype was developed using offline mobile app architecture. Subsequent testing confirmed the prototype adhered fully to design and database specifications. In December 2020, a re- test involving 13 farmers and 11 agricultural officers was conducted, gauging perceptions of ease of use, interface satisfaction, and usefulness. The median scores for these domains were 6.000 (IQR: 1.3000), 6.1875 (IQR: 1.0625), and 6.0833 (IQR: 1.2083) respectively. Generally, a new Malay language app - 'Perosak & Penyakit Padi' has been successfully developed with the intention of aiding local farmers in making decisions regarding insecticide application for rice insect pest management.

Key words: database, rice pest and disease, decision support system, smartphone, Malay language

INTRODUCTION

Rice (*Oryza sativa*) is a common staple in Malaysia and other Southeast Asian nations. Nevertheless, insect pests are the principal problems that have a considerable impact on the amount and quality of rice harvested during the growing season. In Malaysia, approximately 15 to 20% of the total rice area is infected with diseases (Banniza and Holderness 2001), and 37% of yield loss every year was reported by the International Rice Research Institute (IRRI 2015). The rice plant is susceptible to more than 100 species of insects from which, about 20 can cause economic damage (Pathak and Khan 1994), and termed as major pests. Around 18 insect pests and 14 diseases have been identified as major and common to rice in Malayisia (Abdullah et al. 2012; DOA Malaysia 2018; Ooi 2015; Saad and Amzah 2016).

Over the years, the application of pesticides has become the primary strategy in the management of rice pests due to their effectiveness, ease of use, and noticeable results. However, some farmers continue to use pesticides even when insect pest levels are low, leading to concerns about pesticide overuse (Beltran et al. 2016; Gianessi 2014; Ngin et al. 2017). This overuse may result in significant negative consequences, including environmental damage, potential health risks, pest resurgence, the elimination of natural predators, outbreaks of secondary pests, and the development of pesticide resistance, all of which lead to increased production costs (Fuad et al. 2012; Hong-Xing et al. 2017; Mohamed et al. 2016). To mitigate these negative effects, it is important to adopt Integrated Pest Management (IPM) in rice pest management. In particular, IPM emphasizes monitoring pest populations and intervening only when pest levels reached the Economic Threshold Level (ETL). The ETL is defined as the level of pest population density at which pesticide use is justified which takes account the pest-host relationship, crop market value, controls costs and potential crop yield (Bouhssini and Trissi 2018). Therefore, the pest population plays a crucial role in determining the ETL and integrating it into IPM practices. Continuous use of pesticides has impact on the environment, user and consumer. To reduce this impact, the EIQ equation which include the risk hazard to farms workers, consumer and environment has been widely used to reflect these risk (Kromann et al. 2011), where a larger EIQ value represents a greater risk imposed by the pesticide. The MoA classification has been introduced by the Insecticide Resistance Action Committee (IRAC) and Fungicide Resistance Action Committee (FRAC) which serves as guidelines to reduce the pesticide resistance (Sparks and Naue 2015). Incorporating these information for pest management by farmers could effectively control pests while minimizing the use of pesticides and reducing negative impacts on the environment, health, and production costs.

As information technology has advanced, many mobile applications (apps) have been developed to help rice farmers manage pests and diseases. In Malaysia and Indonesia, several apps have been developed in the local language to make them more user-friendly to local farmers such as 'PadiKu,' (https://www.apkpure.com/nl/padiku/com.dwisukoco.padiku) 'MARDI MyPerosakPadi' (https://play.google.com/store/apps/details?id=my.gov.mardi.perosakpadi) and 'Dokter Penyakit Padi' (https://apkpure.net/dokter-penyakit-padi/com.alfianptik.dokterpenyakitpadi#google_vignette). While these apps offer a wealth of information, these do not provide guidance for decision making in pest and disease management, information on the appropriate timing of chemical control, calculation of ETL, or field scouting techniques that allow farmers to observe exact pest density. Consequently, there is still a need for decision support systems to help farmers determine when to use pesticides. This study sought to develop an ETL calculator, within a smartphone app, to assist local rice farmers in making pest management (insect pest and disease) decisions based on the principles of IPM.

MATERIALS AND METHODS

Development of database. To create an Android app called 'Perosak & Penyakit Padi' in the Malay language, a database consisting of pest management information related to rice pests and diseases was created. A total of 18 major rice pests and 14 disease were shortlisted from local references (Abdullah et al. 2012; DOA Malaysia 2019; Ooi 2015). A database containing pests and disease management information for the shortlisted pests and diseases was developed in Google Sheets. In the database, information compiled for each pest or disease included photographs and descriptions of the pests and diseases, general and technical information regarding the management, the ETL figure and field survey method, and the control methods based on IPM approaches (Fig. 1).

All photographs of insects and diseases included in the database were confirmed by the Department of Agriculture (DOA) Malaysia. Additionally, the ETL figure and field survey method were developed with guidance from DOA Malaysia and IRRI (DOA Malaysia 2018; Reissig et al. 1986). Besides, the chemical list for the rice pests and diseases was directly obtained from the local authorized pesticide website (SISMARP) (URL: http://www.portal.doa.gov.my/sismarp/) which was recommended by DOA Malaysia. The SISMARP chemical list only included the pest name (general and scientific), the active ingredient (a.i) of the pesticide, and the pesticide's brand name. However, according to the Insecticide Resistance Action Committee (IRAC) and Fungicide Resistance Action Committee (FRAC), the Mode of Action (MoA) group is able to guide farmers in pesticide selection when used in an alternation or rotation-based resistance programme (Hermann and Stenzel 2019; Sparks and Nauen 2015), thus the MoA group was added manually on the chemical list; Additionally, the Environmental Impact Quotient (EIQ) Pesticide Value (Walter-Echols and Wulp 2008) obtained from the official website, has also been added in the chemical list, to assist chemical users in selecting the least hazardous pesticide by comparing the calculated EIQ Field Use Rating (the EIQ Pesticide Value multiplied by the application rate and the concentration of active ingredient), in which the lowest EIQ Field Use Rating would be the least toxic choice. Lastly, the database developed has been cross-checked among study members, comprising experts in pesticides.

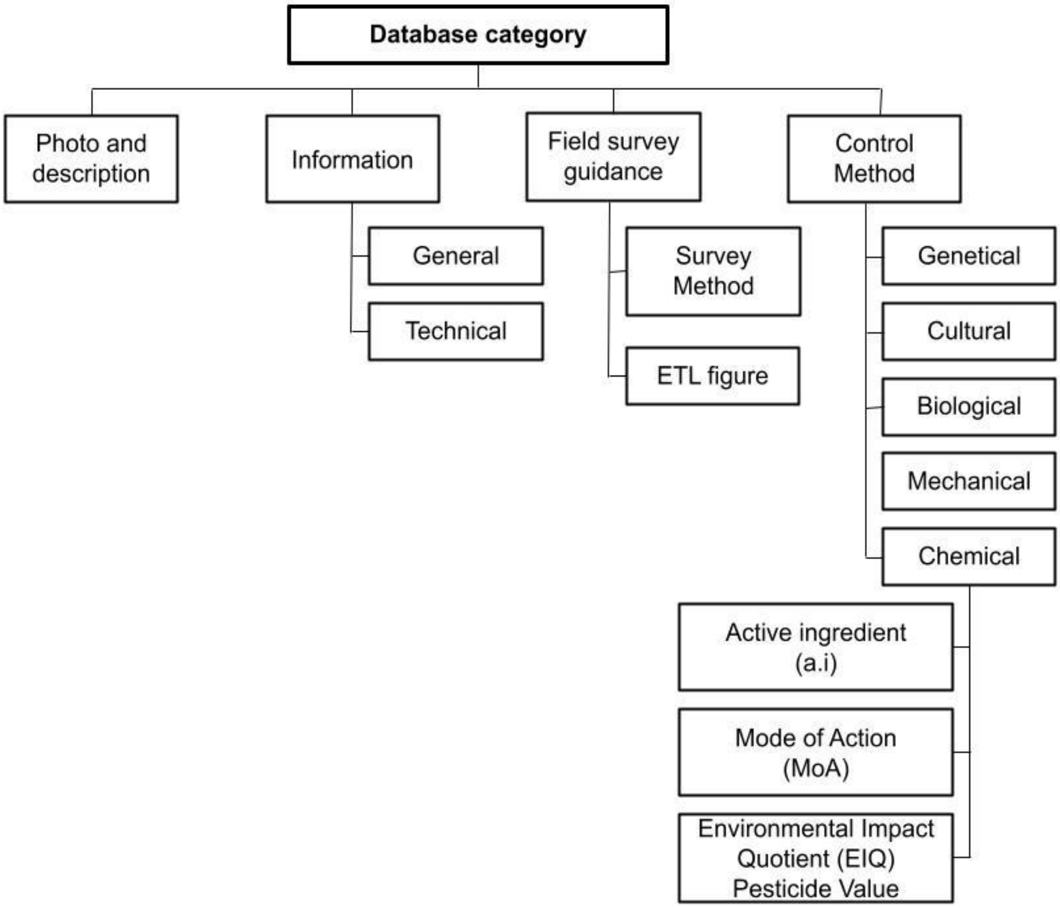

Figure 1: Database categories

Development of android system. Upon completion of the database compilation, a smartphone app was subsequently developed in the Android system. The system flow was initially proposed in a diagram and storyboard before it was prototyped (Fig. 2). The system storyboard involved 13 activities, including account registration, login, reset password, planting stage, rice disease, rice pest, survey method, data page, photo page, information page, control methods, references, and ETL calculator. Additionally, a Microsoft Excel 365 demonstration of the ETL calculator for those insect pests has been created using the mean formula (syntax =AVERAGE (X:X)) and the IF function (syntax = IF(X=>10,">ETL", "ETL"). To ensure the result was identical to the ETL figure, a series of random numbers have been entered into each cell, two cells, three cells, and so on until all ten (10) cells. Subsequently, the prototype development was executed. To avoid internet connectivity issues in the rice field, the app was developed offline, so it will not be influenced by internet connectivity once installed on the mobile device. Lastly, every single click or page change for all the activities of the developed prototype has been verified as the proposed system flow and storyboard, including the ETL calculator cross-checked to the Microsoft Excel 365 demonstration.

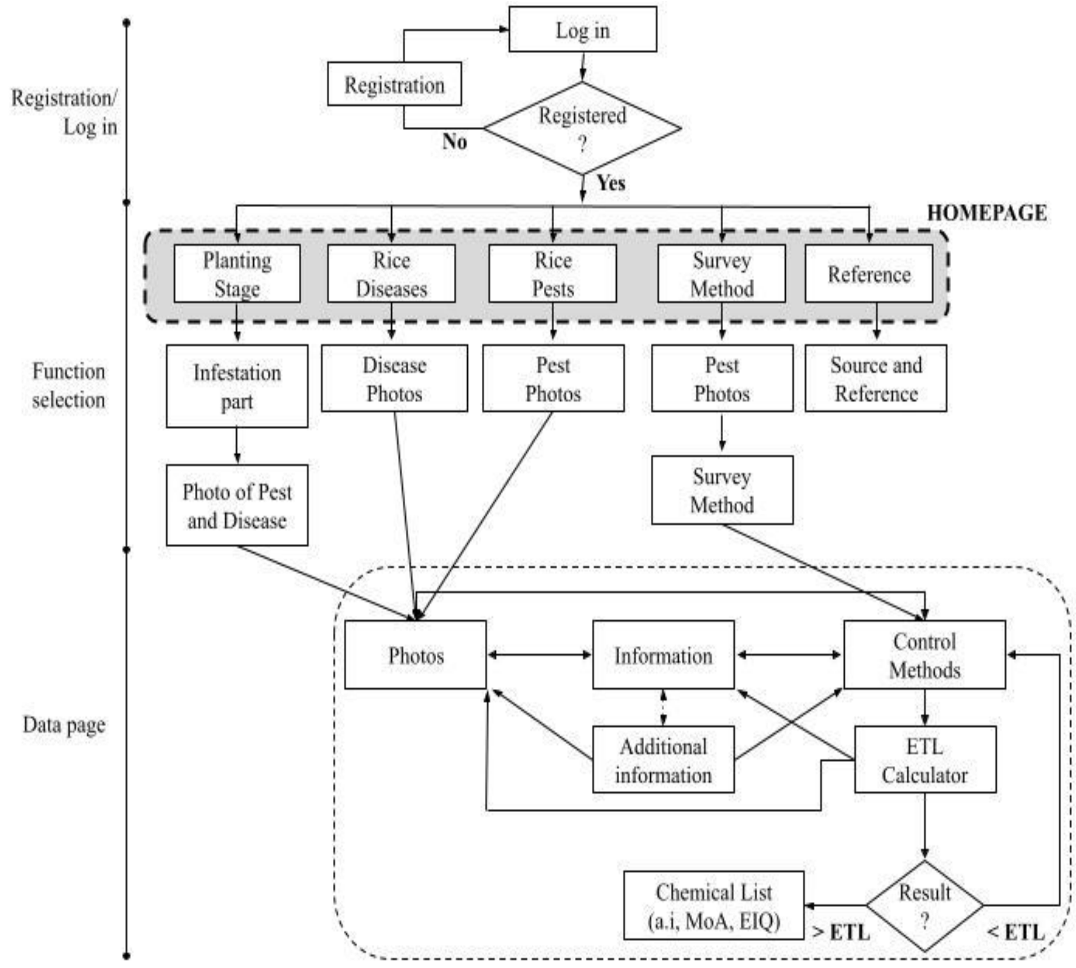

Figure 2: System flowchart

Usability of App. The developed android app was tested at the Integrated Agriculture Development Area (IADA) Kerian, Perak, which is the third largest paddy field in Peninsular Malaysia. This area covers 21,219 hectares of paddy field and has been producing 3.2 tons of rice per hectare each year (DOA 2021). An extension seminar regarding the "*Perosak & Penyakit Padi*' app was organized at IADA Kerian involving rice farmers and agriculture extension officers from the Kerian district. A purposive sampling was conducted among the rice farmer and agriculture extension officers IADA Kerian. The purposive sampling is a non-probability sampling technique typically used in qualitative research to identify and select the information-rich cases for the most proper utilization of available resources (Patton 2002). This involves identification and selection of individuals or groups of individuals that are proficient and well-informed with a phenomenon of interest (Creswell and Clark 2011). The criteria of the farmers respondent are they must be familiar with smart phone, had used phone apps and conducted pest monitoring on field. While for the officers, all agriculture extension officers from IADA Kerian participated in the study. This app usability test included the agriculture extension officer as this could be as their references in giving advice to the farmers. A 30-minute introduction about the app content and how to use the app were provided by the researcher, then the Android Package Kit (APK) was installed into their smartphones. Informed consent was obtained from all participants, and they were requested to use the app and answer the questionnaire. During the session, the researchers are there to assist the respondent using the app and clarify the questionnaire. All data were analyzed using descriptive and comparative analysis by SPSS Version 23.

RESULTS AND DISCUSSION

Database and android system developed. The information content of the application plays an important role in guiding farmers to make the right decisions in a specific field. Singh and Gupta (2017) stated that for decision making in pest and disease management, it started with pest identification, followed by pest scouting and analysis of information. These components included in the "Penyakit & Perosak" app. The prototype of the Android smartphone application was successfully developed in November 2020 based on the predetermined design and database specifications as shown in Table 1. The predetermined design and database specification followed the guidelines and principles from software UI/UX design and database management (Coronel and Morris, 2015). The database included 18 insect pest and 14 diseases. However, the ETL are more comprehensive on the 18-insect pest as referred to IRRI (2015). In the app, the user will have to monitor the field and add the number of the pest in the ETL calculator. The user interface (UI) is shown in Figure 3. A total over 2000 UI was developed started with the user login and registration until control method decision. Figure 3 shown part of UI where the type of pest, enter the pest monitoring data for ETL calculation, as the data are over the ETL, thus the final interface gave suggestion for insecticide use (a.i, MOA and EIQ). The finalized prototype has been tested with the verification plan by the author and co-authors of the study and found that the prototype was developed 100% as proposed. The verification has been done for the 12 activities (Account registration, login, reset password, planting stage, rice disease, rice pest, survey method, data page, photo page, information page, control methods, and references) and found 100% similar with the proposed design and database.

Table 1: ETL and survey method for 18 insect pests

Insect pest ***(Scientific name)***	**Timing**	**Survey method**	**ETL**	**Option**
Brown planthopper *(Nilaparvata lugens)*	40 DAS and above	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other.	10 nymphs/ hill	Nymphs
		2. Tap each (15cm x 15cm) and count the number of adult planthoppers OR mature	5 adult planthoppers/ samples	Adult planthopper

Insect pest ***(Scientific name)***	**Timing**	**Survey method**	**ETL**	**Option**
		nymphs (brown) that fall into the rice field water. 3. To calculate the ETL, enter the total number of adult planthoppers OR mature nymphs into the ETL calculator (ETL).		
Whitebacked planthopper (*Sogatella furcifera*)	30 DAS until flowering stage	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other.	10 nymphs/ samples	Nymphs
		2. Tap each sample (15cm x 15cm) and count the number of adult planthoppers OR mature nymphs (brown) that fall into the rice field water. 3. To calculate the ETL, enter the total number of adult planthoppers OR mature nymphs into the ETL calculator (ETL).	5 adult planthoppers/ sample	Adult planthopper
Black rice bug (*Scotinophara coarctata*)	All stages	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Count the number of adult and nymph Black rice bugs in each sample (15cm x 15cm) 3. Count the total number of adult AND nymph Black rice bugs and enter the total number into the ETL calculator to get the Economic Threshold Level (ETL)	2 / sample	-
Southern green stink bug (*Nezara viridula*)	A week before milk stage until hard dough stage	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Count the number of adult and nymph Southern green stink bug in each sample (15cm x 15cm) 3. Count the total number of adult AND nymph Southern	2 / samples	-

Insect pest *(Scientific name)*	**Timing**	**Survey method**	**ETL**	**Option**
		green stink bug and enter the total number into the ETL calculator to get the Economic Threshold Level (ETL)		
Rice gundhi bug / Rice bug (*Leptocorisa sp.*)	A week before milk stage until hard dough stage	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Count the number of adult and nymph Rice bug in each sample (15cm x 15cm) 3. Count the total number of adult AND nymph Rice bug and enter the total number into the ETL calculator to get the Economic Threshold Level (ETL)	2 / sample	-
Cutworm (*Spodoptera sp.*)	All stages	1. Choose ten (15cm × 15cm) tree samples at random from one corner of the rice field to the other. 2. Count the number of adult and nymph Cutworm in each sample (15cm x 15cm) 3. Count the total number of adult AND nymph Cutworm and enter the total number into the ETL calculator to get the Economic Threshold Level (ETL)	1 / sample	-
Armyworm (*Mythimna separata*)	All stages	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Count the number of adult and nymph Armyworm in each sample (15cm x 15cm) 3. Count the total number of adult AND nymph Armyworm and enter the total number into the ETL calculator to get the Economic Threshold Level (ETL)	1 / sample	-

Insect pest *(Scientific name)*	**Timing**	**Survey method**	**ETL**	**Option**
Green rice leafhopper (*Nephotettix sp.*)	20 DAS until 60 DAS	1. Do the survey in the morning since Green rice leafhopper will be on top of the leaves in cool weather. 2. Wave the 35cm diameter net up to 25 times along the side of the rice field 3. Calculate the number of adult and nymph Green rice leafhopper and enter it into the ETL calculator to get the Economic Threshold Level (ETL)	5 adults/ wave 25 times	The site not ever attacked by Tungro virus disease
			1 adults/ wave 25 times	The site was attacked by Tungro virus disease
Rice leafroller (*Cnaphalocrocis medinalis*)	20 DAS until 50 DAS	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Choose five leaves at random from each to count the number of leaves attacked by the Rice leafroller 3. Enter the number of attacked leaves into the ETL calculator to calculate the Economic Threshold Level (ETL)	Attacked leaves > 15%	20 DAS until 50 DAS
	50 DAS until 90 DAS		Attacked leaves > 5%	50 DAS until 90 DAS
Yellow stem borer (*Scirpophaga incertulas*)	20 DAS until 45 DAS and 75 DAS until 85DAS	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Count the number of stem borer eggs in all the samples (Eggs can be found at the end of the leaf surface and midrib and are usually covered with hairs) 3. To get the Economic Threshold Level, use the ETL calculator and enter the number of eggs discovered in each sample (ETL)	No. of eggs/ 10 trees > 2	< 60DAS
			No. of eggs/ 10 trees > 1	> 60DAS
Dark-headed striped borer (*Chilo polychrysus*)	20 DAS until 45 DAS and 75 DAS until 85 DAS		No. of eggs/ 10 trees > 2	< 60DAS
			No. of eggs/ 10 trees > 1	> 60DAS
Pink stem borer (*Sesamia inferens*)	20 DAS until 45 DAS and 75 DAS until 85 DAS		No. of eggs/ 10 trees > 2	< 60DAS
			No. of eggs/ 10 trees > 1	> 60DAS

Insect pest ***(Scientific name)***	**Timing**	**Survey method**	**ETL**	**Option**
Striped stemborer (*Chilo suppressalis*)	20 DAS until 45 DAS and 75 DAS until 85 DAS		No. of eggs/ 10 trees > 2	< 60DAS
			No. of eggs/ 10 trees > 1	> 60DAS
Common evening brown (*Melanitis leda ismene*)	30 DAS until Flowering stage	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Choose five leaves at random from each to count the number of leaves attacked by the Common evening brown 3. Enter the number of attacked leaves into the ETL calculator to calculate the Economic Threshold Level (ETL)	Attacked leaves > 15%	-
Rice gall midge (*Orseolia oryzae*)	From seedbed to panicle initiation (0 – 60HLT)	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Choose five leaves at random from each tree to count the number of leaves attacked by the Rice gall midge (The attacked rice seedlings will be like a light green onion plant that will not produce stalks, the leaves will be deformed, dry and curled) 3. Enter the number of attacked leaves into the ETL calculator to calculate the Economic Threshold Level (ETL)	Attacked leaves > 5%	-
Rice caseworm (*Nymphula depunctalis*)	0 until maximum tillering (45 DAS)	1. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 2. Choose five leaves at random from each tree to count the number of leaves attacked by the adult Rice caseworm	Attacked leaves > 50%	Before 20 DAS
			Attacked leaves > 15%	20 DAS until 50 DAS

Insect pest ***(Scientific name)***	**Timing**	**Survey method**	**ETL**	**Option**
		3. Enter the number of attacked leaves into the ETL calculator to calculate the Economic Threshold Level (ETL)		
Ricefield rat (*Rattus sp.*)	All stages	1. Determine the number of seedlings in a sample (15cm x 15cm) 2. Choose ten (15cm × 15cm) samples at random from one corner of the rice field to the other. 3. Count the number of leaves that have been cut or attacked by the Ricefield rat 4. Enter the total number of seedlings and the number of leaves attacked into the ETL calculator to get the Economic Threshold Level (ETL)	5% attacked	-
Golden apple snail (*Pomacea sp.*)	0 until 30 DAS	1. Do the survey from 0 to 30 days after sowing (HLT), especially before 20 HLT when the damage attack is extremely high 2. Choose two (2) survey samples (1m x 1m in size) at random in the paddy field 3. Calculate the number of adult and juvenile golden apple snail in the survey sample, and enter into the ETL calculator to get the Economic Threshold Level (ETL)	1 / m^2	0 until 30 DAS

Furthermore, the ETL calculator in the prototype encountered a total of 990 steps to verification, in which every activity in the calculator counts as one step, and the number entered in each column of the calculator must be given the relevant result as the output. A series of random numbers have been entered into each column, two columns, three columns, and so on until all ten (10) columns, the estimated output must be the same as the Microsoft Excel 365 demonstration. If the estimated output was below the ETL and the app subsequently moved back to the control methods page (Fig. 3A and 3C), this step was deemed correct and passed the verification. Similarly, if the estimated output value was equal to or greater than the ETL and the app displayed the chemical list indicated for the specific pest or disease (Fig. 3A and 3B), this step was deemed to have passed the verification. The author and co-authors tested the ETL calculator in the prototype and discovered that it had been created just like the Microsoft Excel 365 Demonstration.

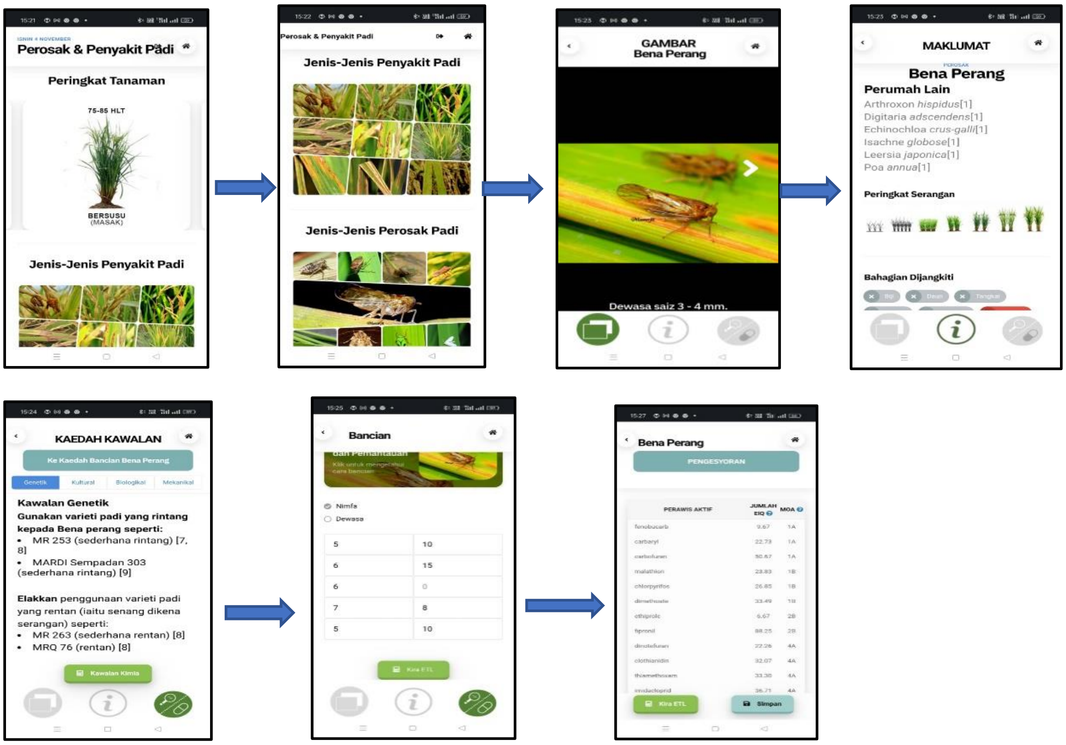

Figure 3. The flow of app interface, after log in, the user will choose the palnting stage to looks for pest symtoms or directly to type of pest. After choosing the specific pest, varios control methods will be given. If the farmer want to use pesticide, they will have to add monitoring input which will then calculate the ETL. If the populatin above the ETL, the final pag is the type of pesticide with informationof active ingredient, EIQ risk and MOA.

Usability test. A total of selected 24 respondents were selected and consented to participate in the usability-test in December 2020. Since this study had a small sample size, determining the distribution of the app usability variables (Ease-of-use, Interface and satisfaction, and Usefulness) was important for choosing an appropriate statistical method. Thus, a Shapiro-Wilk test was conducted and showed that the distribution was significantly non-normal for all 22 items or variables of app usability attributes ($W = 0.612$ to 0.871, p-value < 0.05). Based on this outcome, a non-parametric test was used, and the median with the interquartile range was used to summarize the app usability variables.

Respondents were young to middle-aged adults, recording a median age of 36.5 years old (Interquartile range, IQR: 30.25, 40.75). Two-thirds of the respondents had furthered their studies after secondary school and hold certificates/diplomas and higher educational certificates (66%). Besides that, the median tenure involved in rice farming was 10.18 years (IQR: 5.75, 14.25). One-third of them have used at least one of the existing agricultural apps prior to this survey (Table 2). The results showed that although 66% of respondent had higher education, only 33.3% used the rice related decision support app. As the study objective is to ensure that the development of the ‘’Penyakit & Perosak’’ app is applicable and easy to use by end-user, it does not include the reasons of low usage off\ rice app by respondent. However, a study in Myanmar stated that the important constraints for adoption of agricultural apps are lack of access to internet and lack of digital knowledge (Thar et al. 2020). While in Nigeria an earlier study found factors affecting adoption of digital application tools in agriculture as education, training, internet access, smartphone ownership, awareness of application tools and the cost of digital tools (Abioye et al. 2024).

Table 2. Respondents' demographic profile

Occupation	n	%
Farmer	13	54.2
Officer	11	45.8
Age, years, median (IQR)	36.5	(30.25, 40.75)
Educational level		
No formal schooling	1	4.2
Primary school	1	4.2
PMR/ SRP	1	4.2
SPM/ SPMV/ MCE	5	20.8
Certificate/ Diploma	11	45.8
Degree/ Master/ PhD	5	20.8
Tenure involved in rice farming, years, median (IQR)	9.50	(5.75, 14.25)
**n = 22, two data were incomplete		
Use another rice App before	n	%
Yes	8	33.3
No	6	66.7

The median score for the attribute 'Ease-of-use', 'Interface and satisfaction', and 'Usefulness' were 6.000 (1.3000), 6.1875 (1.0625), and 6.0833 (1.2083), respectively (Table 3). These median scores were higher than 5.99, indicating that the respondents were satisfied with the usability of the app, particularly its content and functionality. The score for these attributes is high, thus it has achieved the objective of the user's preference of platform interface and usefulness.

Earlier studies on the ease of use have been done (Cervera et al. 2015; Upadhe et al. 2018). The ease-of-use terms refers to the extend to which understanding, learning and operating a specific system or technology is free of physical and mental effort (Davis, 1989; Tandon 1t al. 2016). The attributes of ease of use and its usability are important attributes for the app platform to survive and operate successfully.

Table 3. App usability of three attributes

Attributes	**N**	**Min**	**Percentiles**			**Max**
			25	**50**	**75**	
Easy-to-use	24	1.80	5.6500	6.0000	6.9500	7.00
Interface and satisfaction	24	4.13	5.8750	6.1875	6.9375	7.00
Usefulness	24	4.33	5.4167	6.0833	6.6250	7.00

Subsequently, the study found that 18 out of 19 items received high median scores. Particularly, the items: 'the image in the app was attractive', 'I would use this app again', and 'The app would be useful in rice pest and disease management in my field' scored a median score of 7.00 (IQR: 1.00), 6.50 (IQR: 1.00) and 6.50 (IQR: 1.00), respectively.

The images of the insect pest and the symptoms in the app are in high-definition quality, with simple and easy to understand explanation. During the development stage, the clear images and simple instructions were some of the functions that were highlighted. Thus, these attributes have higher mean values which showed that the consumer perceived of the ease of use and usefulness are important factors that will lead to higher consumer satisfaction of the app (Moslehpour et al. 2017). The function for IPM such as ETL, EIQ and MOA is to encourage the farmers to adopt more IPM strategies as pest management practices. An earlier study found farmers trained on EIQ, had reduced the frequency of pesticide use by 17.9/ ha in Jammu (Sharma and Peshin 2016). A control of pink bollworm resistant program where farmers were trained on IPM which implemented the ETL of the pest, together with MOA and EIQ successfully reduced the pest infestation, increased benefit:cost ratio, and reduced number of pesticide usage (Nagrare et al. 2023).

On the other hand, a lower median score was obtained for item 'This app has all the functions and capabilities I expected it to have', which was 5.50 (1.75) (Table 4). The median score might be due to the fact that this app is built for offline, to avoid internet connectivity problem. Thus, the interactive functions such as chats to enable one to connect with related agencies are not available. However, the average scores for all attributes in this study has high median score, which showed the acceptability of these app by the consumer in the future is high. An earlier study mentioned the user perceived ease of use and usefulness are the two main factors for the acceptance of information systems (Davis 1989).

Table 4. App pre-test for each attribute.

Attributes	N	Min	Percentiles			Max
			25	50	75	
Easy1 - The app was easy to use	24	1	6.00	6.00	7.00	7
Easy2 - It was easy for me to learn to use the app	24	2	5.00	6.00	7.00	7
Easy3 - The interface of the app allowed me to use all the functions (such as choosing the plant part, entering pest number in ETL calculator, viewing information) offered by the app	24	2	6.00	6.00	7.00	7
Easy4 - Whenever I made a mistake using the app, I could recover easily and quickly	24	1	5.00	6.00	7.00	7
Easy5 - The ETL calculator in the app was easy to use	24	2	6.00	6.00	7.00	7
Int1 - I like the interface of the app	24	1	6.00	6.00	7.00	7
Int 2 - The information in the app was well organised, so I could easily find the information I needed	24	1	6.00	6.00	7.00	7
Int 3 - The image in the app was attractive	24	3	6.00	7.00	7.00	7
Int 4 - The colour used in the app was attractive	24	5	6.00	6.00	7.00	7
Int 5 - The text in the app was clear and easy to read	24	2	6.00	6.00	7.00	7

Attributes	N	Min	Percentiles			Max
			25	50	75	
Int 6 - The language used in the app was easy to understand	24	2	6.00	6.00	7.00	7
Int 7 - I would use this app again	24	2	6.00	6.50	7.00	7
Int 8 - Overall, I am satisfied with this app	24	3	6.00	6.00	7.00	7
Useful 1 - The app would be useful in rice pest and disease management in my field	24	5	6.00	6.50	7.00	7
Useful 2 - The app improved my knowledge in rice pest and disease management (such as I am able to know the active period of certain disease, the behaviour of pest)	24	3	6.00	6.00	7.00	7
Useful 3 - The app helped me in rice pest and disease management effectively (such as through the survey method, control recommendations like biological, mechanical and cultural)	24	2	5.00	6.00	7.00	7
Useful 4 - This app has all the functions and capabilities I expected it to have	24	4	5.00	5.50	6.75	7
Useful 5 - I could use the app even when the Internet connection was poor or not available	24	1	6.00	6.00	7.00	7
Useful 6 - The app helped me to make the right decision in chemical use for rice pest and disease (such as ETL calculator and EIQ reference)	24	4	6.00	6.00	7.00	7

CONCLUSION

The functions of the app tested are acceptable with median score of high medians for its images, information of pest, ETL calculator and simple text. This is an important function of the app, where the decision from the ETL could help farmers to determine the need to apply pesticides. The ease of use and the usability functions of this app has a high rating, which showed the respondents are satisfied with its functions. The "Perosak & Penyakit Padi" app can be a valuable tool to reduce the number of insecticide applications in rice, avoid using insecticides in the same MOA group as well as choosing hazardous pesticides, consequently making the effective and right insecticide selection for chemical control. However, the lowest median score was on the attribute wherein the user expected more functions and capabilities of the app. This could be due to the fact that this app is for the offline user, the functions for real-time is not available. Thus, in the future this app could be developed for online platforms where it could be downloadable anywhere.

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DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. This publication is part of a thesis for the fulfillment of Master's degree in Science (Pest Management).

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