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Assessment of Farmer Characteristics and Design Preferences on Location-based Pest and Disease Reporting Service for Digital Agriculture: A Preliminary Analysis

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Abstract. User interface design is critical for ensuring that agricultural technology is accessible and usable for farmers. Usability and accessibility for farmers can boost crop yields and lower losses. Therefore, it is crucial to understand the preferences and needs of farmers, particularly in terms of user interface design. This study examines the preferences of chili farmers for user interface elements in reporting chili pests and diseases and investigates how farmer characteristics (i.e. age categories and educational backgrounds) influence these preferences. Data was collected from a group of chili farmers in Batu Pahat using a survey instrument and field experimental tasks that list several user interface elements according to the tasks given in relation to disease and pest attack reporting information for chili crops. The study includes user interface-related tasks for online map services such as Google Maps and Waze, which aim to report the location of attacks. The study's findings underscore the significance of user interface elements in shaping user experiences. Google Maps emerged as the favored navigation service, highlighting the importance of a straightforward and user-friendly interface. The study suggests that enhancing user knowledge of lesser-known functions can lead to higher satisfaction and loyalty. In agricultural applications, visual cues and intuitive design, exemplified by the "Picture Radio Button" and "Horizontal Date" elements, were well-received. Overall, this study highlights the importance of considering farmers' demographic characteristics in designing user interfaces for agricultural technology. By doing so, agricultural technology can be made more accessible and usable for farmers, ultimately leading to more effective management of chili pests and diseases. The findings of this research will yield advantages by aiding farmers, specifically in Malaysia, in transitioning into intelligent farmers, aligning with the objectives of the Shared Prosperity Vision 2030 and the realization of smart agriculture in Malaysia. Furthermore, this endeavor is consistent with the Food and Agriculture Organization of the United Nations (FAO) initiative aimed at digitizing farmers, encompassing smallholder farmers as well.

1. Introduction

The concern over food production through agriculture is crucial for a country's economic strength and survival. Climate change significantly impacts the agricultural sector, which in turn affects food security and its various dimensions such as access, consumption, and stability [1]. Pests and plant diseases are identified as leading constraints in agricultural development which [2] emphasizes the importance of agriculture as a solution for developing countries, contributing to improved food security and climate change mitigation. Information and communication technology (ICT) plays a vital role in assisting agricultural production, particularly through the implementation of precision farming technology in developing nations [3]. ICTs enable better access to information and knowledge sharing among farmers. However, the use of ICT in agriculture does not always guarantee increased yields and profits [4].

In Malaysia, technological innovation in agriculture, particularly in the oil palm and paddy fields, has been a key focus of study. Traditional agriculture has transformed into modern agriculture, incorporating various innovations to enhance productivity. Geographic Information System (GIS) and Remote Sensing (RS) technologies have been employed by the Department of Agriculture Malaysia to map paddy fields and monitor production. [5] aims to promote technology adoption in agriculture to ensure food security and meet the needs of the people. The Department of Agriculture's Strategic Plan (2016-2020) highlights the importance of using ICT, especially geospatial technologies, in managing pests in the agricultural industry. Data obtained through pre-emptive surveillance and pesticide presence information aids in planning effective and environmentally friendly pest control strategies [6]

Agriculture 4.0 represents the fourth agricultural revolution, leveraging digital technologies to advance toward a more intelligent, efficient, and eco-conscious agriculture sector, resulting in the emergence of agricultural technologies aimed at promoting sustainability and unveiling more productive farming practices [7]. The widespread availability, portability, and mobility of digital technologies are reshaping agriculture and food production, particularly through the proliferation of mobile technologies, remote-sensing services, and distributed computing, which are already enhancing smallholders' access to information, inputs, and markets, leading to increased production and productivity, streamlined supply chains, and reduced operational expenses [8]. In the context of this technological revolution, the rapid advancement of mobile technology has transformed the way people interact with their smartphones and other portable devices, with mobile user interfaces (UIs) playing a crucial role in providing an intuitive and efficient user experience (UX). Consequently, in agriculture, mobile applications have become increasingly essential for farmers to streamline operations, enhance productivity, and address challenges like pests and diseases, driven by the expectation of benefits and increased profitability [9]. Therefore, when designing mobile applications, special attention should be given to user interfaces and user experience, particularly considering the diverse backgrounds and lifestyles of farmers from different generations [10].

The increasing use of mobile phones leads to the growth of mobile applications, but some of these applications lack usability due to mismatches between user interface design and user skills, expectations, and needs, especially in rural areas [11], [12], [13], [14], [15], [16], [17]. Designing mobile interfaces poses challenges due to individual factors and user diversity [18], conflicts between mobile design and user need [19], [20], and unfamiliarity with interfaces [21], especially among elderly and female users [18]. Data entry methods pose challenges in designing mobile user interfaces [22]. Issues include the types and locations of interface elements. Problems with embedded maps in mobile interfaces involve conflicts between map and screen boundaries, leading to user errors and frustration [23], [24].

Smallholders play a crucial role in the food supply in Malaysia, but their low productivity, influenced by climate change, poses challenges to food storage and security [25]. Monitoring crop conditions, especially in relation to pests and diseases resulting from climate change, is necessary to mitigate crop damage. However, study on pests and diseases in Malaysia is still insufficient [26]. The use of digital technology in agriculture can contribute to improving the efficiency of the agricultural system, as emphasized by the High-Level Panel of Experts on Food Security and Nutrition [27].

To create a user interface that meets the capabilities and requirements of end users, it is important to integrate demographic variables into the design process [28]. [29] found that demographic factors and a well-designed interface significantly affect the adoption of mobile technology. Adopting a participatory and user-centered design approach, which considers the needs and challenges of rural farmers, is crucial for developing effective digital solutions [15], [30], [31], [32]. This approach should be prioritized before developing mobile interventions that address socioeconomic problems [17].

According to [33] stated User-Centered Design (UCD) is a comprehensive design approach that relies on the active engagement of users to enhance the comprehension of user and task demands, as well as the continual refinement of design and evaluation processes. Employing Human-Centered Design (HCD) in order to craft a user-oriented application design where the user experience (UX) designer comprehends what users truly and directly require is crucial [34]. Therefore, this study aims to employ a user-centered design (UCD) approach by actively involving rural farmers in Batu Pahat, taking into account their age and educational background as influential factors that will shape the design of the user interface to align with their skills.

2. Literature review

In 2022, the United Nations, during the Forum on Digital Technology Empowering Rural Transformation, asserted that the combination of advanced and forward-thinking technologies with traditional agricultural practices has the potential to enhance collaboration and bolster global food security, particularly for rural households and women farmers. According to [35], as our economy continues to undergo technological advancements, recent progress in digital technologies, such as faster computers, mobile phones, sensors, machine learning, and artificial intelligence (AI), has resulted in groundbreaking equipment that is revolutionizing the use of machinery in agricultural tasks. Consequently, it is imperative to employ science and technology in an equitable manner to attain Sustainable Development Goal 2, which entails reducing inequality and fostering economic growth and sustainable livelihoods [36].

According to [26], technology plays a crucial role in enhancing productivity and sustainability in agriculture. The report by [27] states that the widespread adoption of digital technology has the potential to support sustainable strengthening, thereby improving the effectiveness of the food system. To unlock the full potential of digital technology, technology transfer, farmers' education, and transdisciplinary approaches involving scientists, farmers, industries, and governments are deemed necessary. The rapid advancement of information and communication technology (ICT) has introduced various digital technologies, including drones, mobile devices, the Internet of Things (IoT), Global Positioning System (GPS), sensors, Geographic Information System (GIS), and Remote Sensing satellites. These technologies are being employed to facilitate precision farming methods and enhance the agricultural sector.

2.1. Precision Farming

Precision agriculture is becoming part of contemporary agriculture in the small-scale agricultural system of developing countries, which contributes to improving crop productivity and improved food safety and income for farmers while reducing environmental degradation and fostering environmental sustainability [37]. According to the World Bank's report [38], the key drivers for increasing agricultural productivity and increasing income are the use of innovative technologies and practices by farmers. This will enable farmers to improve the quality of their products by adapting to the impact of climate challenges. And because of that, the arrival of information and communications technology (ICT) is timely. ICT is one of the solutions to assist in agricultural production and has introduced the use of precision farming technology in developing countries [3].

Mobile technology helps disseminate information without a time limit [39]. According to the Human Rights Council of Australia [40], the efficient use of mobile technology contributes to a positive impact on rural farmers, and the surrounding community, and strengthens their positions in the market chain. The efficient use of mobile phones also encourages active participation to enhance the social status of farmers and economic development [39]. One of the reasons for failure in information technology intervention is an unsatisfactory design that does not meet the needs of technology users [41]. Furthermore, farmers do not benefit optimally from the leverage provided by mobile phones due to a lack of capability and awareness of the use of mobile phone features and functions [42].

2.2. User Interface for Mobile Technology

The advancement of mobile technology provides increased opportunities for data sharing among individuals. It is projected that by 2025, mobile subscriptions will reach 5.9 billion, primarily driven by development [43]. Smartphones now come equipped with various built-in sensors such as GNSS, camera, microphone, touchscreen, accelerometer, and gyroscope sensors, enabling a wide range of tasks [44]. These sensors can facilitate the creation of mobile applications, including image-based sensors widely utilized in various smartphone applications. However, individuals residing in Southeast Asia and sub-Saharan Africa, where literacy levels are lower [15], face dual challenges in the digital era where they struggle to participate in digital activities.

In the process of designing mobile applications, the user interface (UI) holds immense importance as a vital visual communication element that can greatly influence the app's success [45]. The UI is responsible for presenting the arrangement and visual appearance of various components that make up the app's layout. Design examples play a crucial role in shaping the UI design process [46]. Meanwhile, the design of user interfaces and the usability of systems have significant potential to enhance the adoption of agricultural applications in Malaysia [47]. Particularly in rural areas, farmers require mobile device user interfaces that are tailored to their skill levels. Study by [48] has highlighted instances where farmers' adoption of mobile technology is hindered by usability issues. This is primarily because farmers lack a proper understanding of how to navigate user interfaces on their mobile devices [49].

One of the current trends in user interface design involves creating user-friendly interactions through effective visualization techniques. [50] suggests that various computing concepts have emerged to achieve this objective, including virtual reality (VR), augmented reality (AR), and mixed reality (MR). For instance, mobile navigation apps utilize these ideas to identify optimal routes and present them visually, thereby assisting users in making quick and accurate decisions during emergencies [51]. Moreover, there is a growing popularity of incorporating a dark mode design to enhance visibility in low-light environments, improving usability [52]. Additionally, there is an emerging trend to make user interface elements more interactive, such as the use of emoji sliders on Instagram, which provides a simplified overview of the questions posed in our posts.

Meanwhile, the ability to access a user's location is crucial for effective location analysis or location intelligence purposes [53]. This underscores the importance of emphasizing the functionality and user interfaces of Location-Based Services (LBS) in mobile applications. LBS functionality serves as a valuable guide for users when it comes to tasks such as locating specific places or finding nearby locations for various reports. Effectively presenting visual aids and minimizing extraneous on-screen information are key principles of user-centered design discussed in the study by [54]. These principles should be taken into consideration across different types of aids, including interactive touch displays, static maps, and mobile applications, to create an optimized mobile interface experience.

3. Methodology

The primary focus of this study revolves around farmers engaged in the cultivation of fertigation crops in Batu Pahat. To gather the necessary data, a questionnaire and a field experimental test assessing the preferences of user interface elements were administered to a total of 36 respondents. Given the time constraints faced by these farmers, who are heavily occupied with their agricultural activities, the sample of respondents was chosen using voluntary response sampling. A voluntary response sample is characterized as a sample comprising individuals who have willingly opted to take part as members of the sample group. Typically, respondents in such a sample choose to engage with surveys due to their strong opinions about the survey's subject matter. Hence, within this study, the focus is on farmers engaged in chili fertigation, as these are the respondents who have prior experience with technology through fertigation. Embracing technology in farming frequently links with concerns about risk and uncertainty regarding proper implementation, and fit to the existing setting in terms of scale and suitability. Notably, this acceptance also hinges on the viewpoint and anticipations of farmers, particularly those practicing conventional agricultural methods [55].

Throughout the study, strict adherence to study protocols and informed consent procedures was followed to ensure the protection of the rights and interests of the respondents. All respondents willingly provided their informed consent prior to their involvement in the study. The participation of all individuals was confidential and voluntary, facilitated by the Crop Development Agent (APT) of the Batu Pahat Department of Agriculture. This study outlines the quantitative design employed for collecting and analyzing responses. Two primary research strategies were utilized: a survey using a questionnaire and experimental research. According to [56], experimental research aims to assess whether a specific treatment impacts an outcome. In this experiment, a task-based user interface test was employed, where respondents were presented with a scenario of a disease attack on chili crops and provided with the necessary information to create a report.

The focus of this study was solely on data entry for reporting pest and disease attacks on chili crops. The information required for reporting these attacks was based on recommendations from crop development agents and officers of the Johor Bahru Plant Biosecurity Division, taking into account the equipment capabilities of the farmers. For instance, certain information, like soil moisture, was not included in the reporting as farmers lacked the necessary soil sensors required by the Department of Agriculture. The design and development of the user interface for this element were accomplished using KoboToolbox. Meanwhile, the user interface elements employed in this study were chosen based on [15], considering the elements are appropriate for the purpose of data entry.

The task-based user interface elements testing aimed to streamline early-stage diagnostic and monitoring tasks, such as identifying the disease name, recording weather conditions during reporting, estimating the number of affected polybags, documenting pesticide spraying frequency, and noting the last date of pesticide application on crops. However, due to time constraints faced by busy farmer respondents, not all suggested information could be tested during the task-based user interface testing. Consequently, some details, such as the pest's name (considered synonymous with the disease name), were excluded. Additionally, voice recorder user interface elements were not included in this study because of potential data loss or damage, as well as the possibility of capturing background noise that could compromise the clarity of recorded audio.

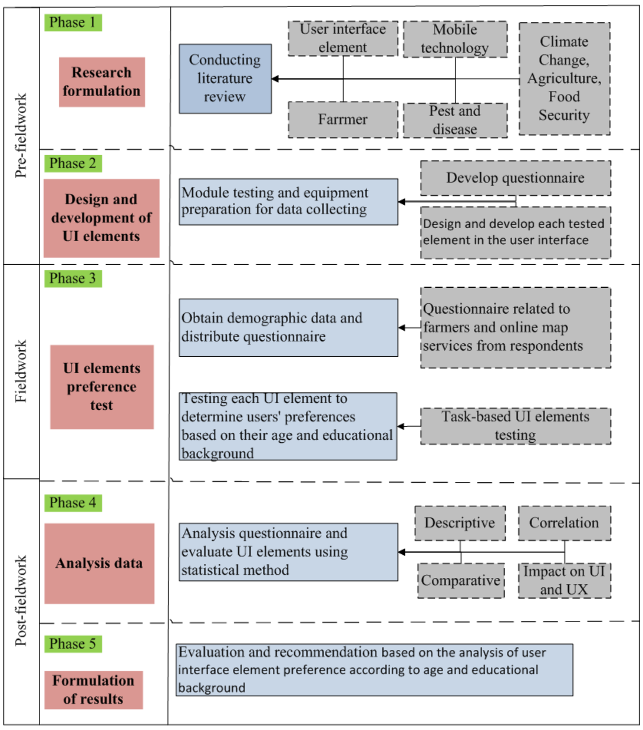

Figure 1. Overall phases workflow of the research framework.

The processes in this study are divided into 5 phases. The description of the study phases in Figure 1 is below:

- Phase 1. In this study, a comprehensive review of existing literature was conducted, focusing on relevant keywords such as user interface elements, agriculture, food security, plant pests and diseases, and mobile technology. The literature review involved analyzing previous studies that are pertinent to our study, including examining the terminology, methodologies, and parameters employed by this study.
- Phase 2. During the pre-field phase, the necessary test modules and equipment for data collection are prepared in advance before the fieldwork stage of the survey and experiment. A questionnaire is developed to gather demographic information from respondents, as well as assess their knowledge and familiarity with online map services. Simultaneously, user interface elements are devised and developed for the purpose of testing respondents in the field.
- Phase 3. The data collection process in the field encompasses two activities. Firstly, distributed questionnaires are used, containing demographic questions about the respondents, along with inquiries about online map services. The focus is on three popular online map services: Google Maps, HERE WeGo, and Bing Maps, and an online navigation map called Waze.
  Subsequently, task-based user interface elements testing was conducted, where specific user interface elements suitable for reporting pest and disease attacks on chili crops were designed. For instance, four user interface elements (as shown in Figure 2) were devised for capturing the name of the disease: Radio Button, Picture Radio Button, Drop-down list, and Combo Boxes. Upon completing the tasks related to this information, respondents provided ratings for each of these elements.
- Phase 4. The analysis involved both the distributed questionnaire and the task-based user interface elements testing. This analysis encompassed various aspects, including the demographics of the respondents, their familiarity and knowledge of online map services, as well as quantitative evaluations such as descriptive, comparative, correlation, and the impact of age and education level on usability and experience
- Phase 5. After gathering data in the field, the post-work phase will involve analyzing the information to obtain an initial understanding of the user interface elements that farmers in Batu Pahat prefer, considering factors based on their age and educational background.

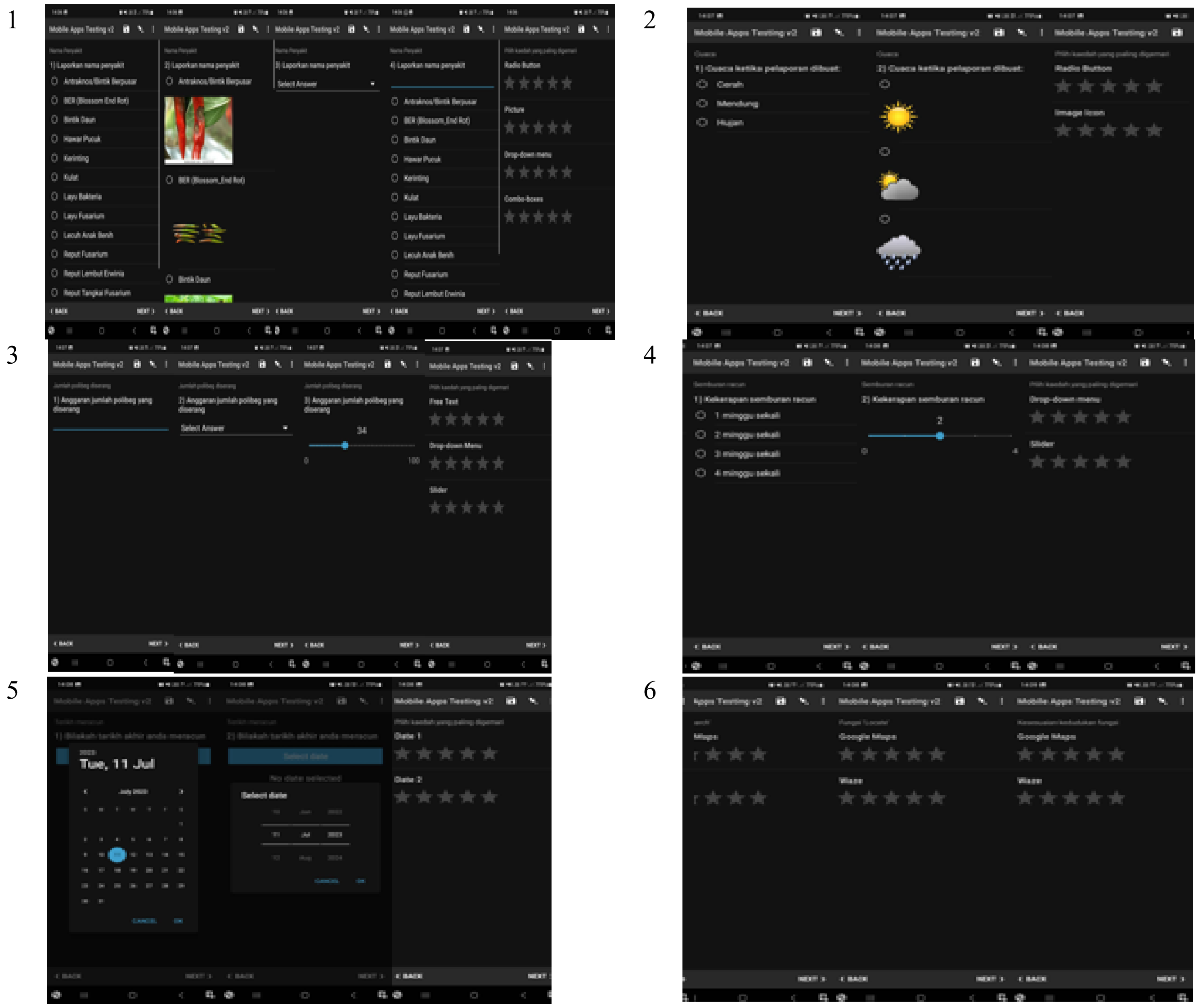

Figure 2. A user interface element for task-based data entry for chili plant pest and disease attack reporting purposes.

Meanwhile, Figure 2 illustrates the six interfaces employed for task-oriented user interface evaluation. These interfaces encompass six distinct reporting categories concerning disease attacks and pests affecting chili plants. Upon furnishing the requisite information, respondents are prompted to assign ratings to the UI elements, corresponding to their preferred choice for each data category. Ratings range from one star (strongly disliked) to five stars (strongly liked). The subsequent clarification pertains to the sub-diagram depicted in Figure 2:

- Sub-figure 1 integrates four UI elements – radio button, picture radio button, drop-down list, and combo boxes (keyword-based search) – to handle disease name data.
- Sub-figure 2 involves two UI elements – radio button and icon image – for capturing weather conditions when farmers encounter crop diseases and pests.
- Sub-figure 3 employs three UI elements – text field, drop-down list, and slider – to record the estimated count of attacked polybags.
- Sub-figure 4 features two UI elements – drop-down list and slider – to capture the frequency of pesticide application within a month.

- Sub-figure 5 encompasses two types of date formats – horizontal dates and dropdown dates – to collect information about the deadline for pesticide application in crops.
- Sub-figure 6 presents three inquiries concerning online map services: the functional aspect, the geolocation component, and the overall compatibility of function positions for Google Maps and Waze.

4. Results and Discussion

4.1. Demographics Profile of Respondents
The respondents were classified based on age into three groups: young adults (18-35 years old; n = 12), middle-aged adults (36-55 years old; n = 14), and older adults (55 years and above; n = 10). The demographic profile of respondents shown in Figure 3 provides valuable context for interpreting the findings. The study included a balanced representation of respondents across the three age categories, with a reasonable number of respondents in each group. This balanced distribution ensures that the results reflect a diverse range of perspectives from different age groups, leading to more robust and inclusive conclusions. Meanwhile, the educational background (see Figure 4) of the respondents also exhibits diversity, with respondents having varying levels of educational qualifications. The inclusion of individuals with different educational backgrounds ensures that the study captures a broad spectrum of user experiences, considering their varying familiarity and comfort with technology and user interfaces

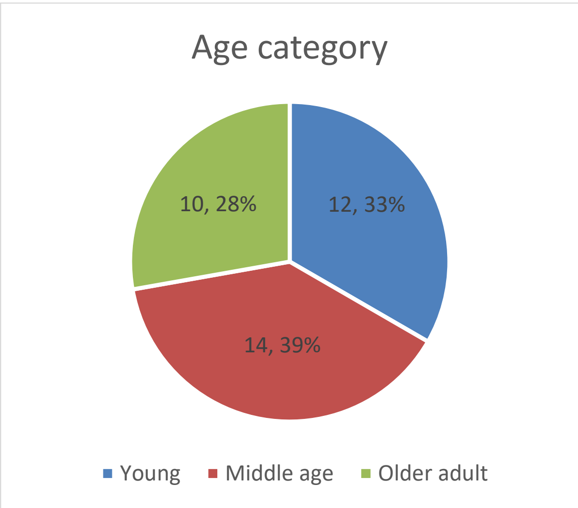

Figure 3. Respondent's age category.

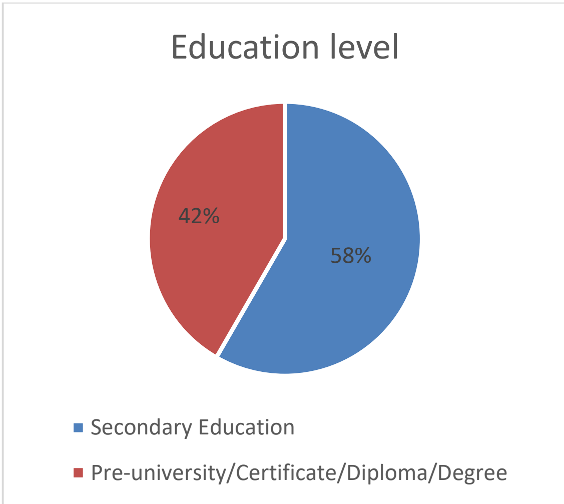

Figure 4. Respondent's education level.

As depicted in Figure 5, Google Maps emerged as the most popular and highly-rated service, with the majority of users expressing strong satisfaction. Waze also garnered significant positive feedback, with a considerable number of users giving it high ratings. On the other hand, Bing Maps received more mixed responses, with a relatively even distribution of ratings across different stars based on Figure 6. HERE WeGo had limited representation in the study, with only one respondent providing a positive experience. This is primarily due to the fact that nearly all respondents are unfamiliar with and have no knowledge about these two online map service platforms.

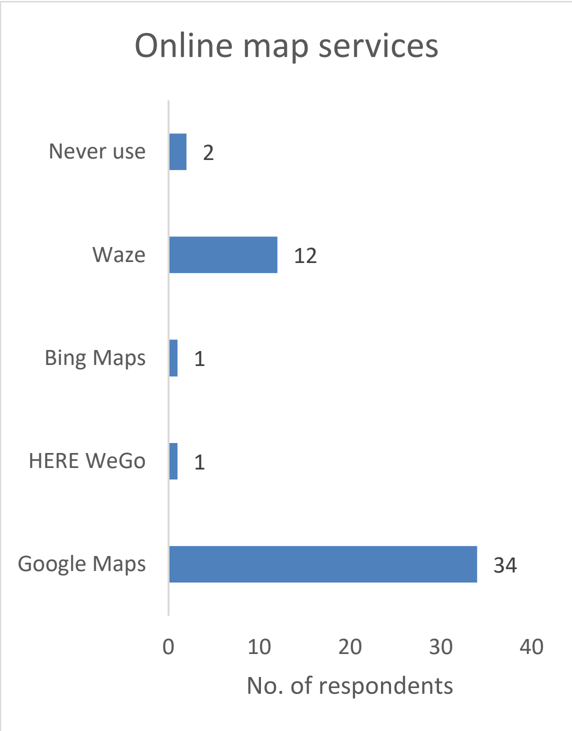

Figure 5. Details provided by respondents about their usage of online map services.

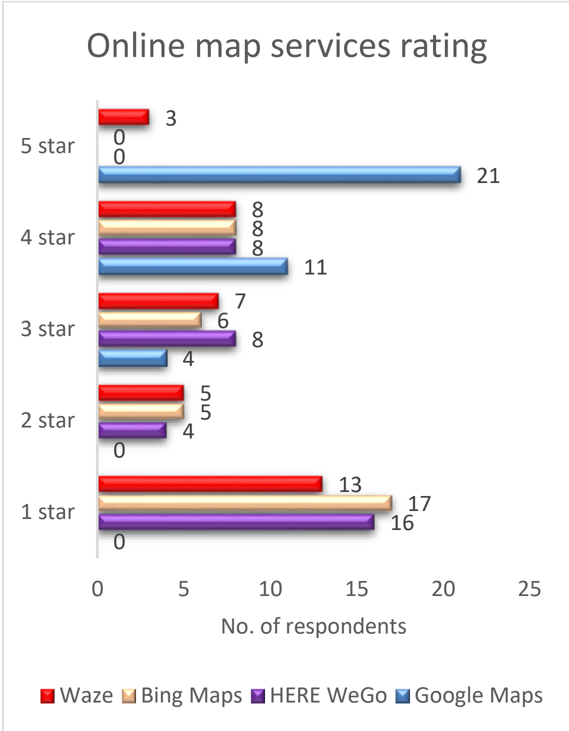

Figure 6. Rating is given to four online map services based on the overall design.

The results based on Figure 7 offer valuable insights into users' map preferences and awareness of fundamental Google Maps functions. Linemap's popularity suggests a continued appreciation for straightforward and user-friendly map representations, while the interest in Imagemap (satellite image) highlights the appeal of detailed and visually immersive views. Meanwhile, Table 8 shows users' widespread knowledge of the Search function and Geolocation feature showcases the significance of these tools in enhancing navigation experiences.

However, the moderate awareness of the Map type layer and a small group of respondents admitted to not knowing any of the three main functions suggesting a need for better user education and enhanced accessibility of basic features in Google Maps. Therefore, increasing user knowledge on less well-known functions can empower users to make the most of the platform's capabilities, ultimately fostering greater user satisfaction and loyalty.

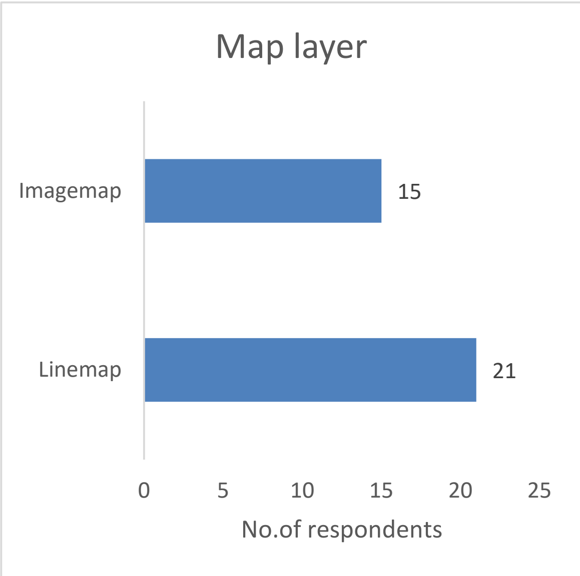

Figure 7. The map chosen by respondents based on familiarity, clarity and ease of understanding.

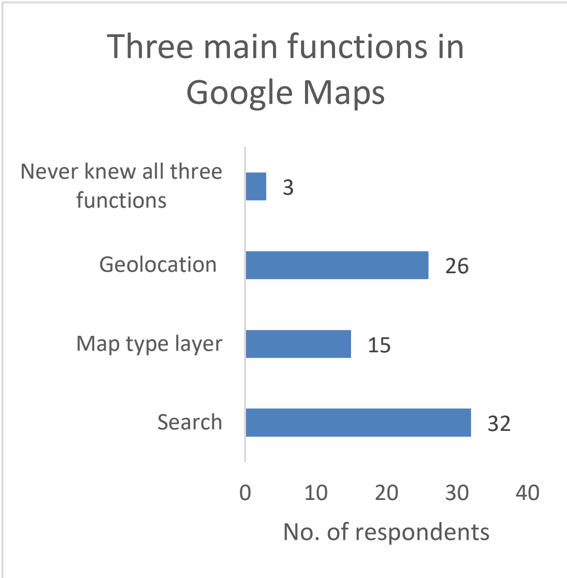

Figure 8. Three primary ffunctions within Google Maps that respondents have been familiar with.

4.2. Task-Based User Interface Elements Testing Descriptive Analysis

Table 1 displays the mean ratings and standard deviations for each user interface element, offering significant insights into user preferences. The findings from this descriptive analysis enlighten on user preferences for different user interface elements, offering designers valuable insights into creating user-friendly and engaging interfaces. The higher mean ratings for the "Picture Radio Button" and "Horizontal Date" elements indicate that users appreciate visual cues and intuitive design when interacting with these elements.

Additionally, the preference for "Google Maps" in terms of overall design positioning highlights the significance of well-structured and visually appealing interface layouts. Designers can leverage these insights to optimize user interfaces, ensuring a positive user experience and enhanced task performance. By understanding user preferences, developers can create more user-centric designs that resonate with their audience and drive overall user satisfaction.

Table 1. Descriptive analysis of task-based user interface elements test.

Data	User interface element	N	Minimum	Maximum	Mean	Std. Deviation
The name of the disease	Radio Button	36	1	5	3.56	1.182
	Picture Radio Button	36	1	5	4.47	1.000
	Drop-down List	36	1	5	3.17	1.404
	Combo Boxes	36	1	5	3.42	1.360
Weather at the time of the report	Radio Button	36	1	5	3.81	1.238
	Image Icon	36	1	5	4.36	1.018
A number of polybags attacked	Text Field	36	1	5	4.03	1.483
	Drop-down list	36	1	5	3.64	1.199
	Slider	36	1	5	3.06	1.393

Frequency of pesticide spraying	Drop-down list	36	1	5	4.44	.969
	Slider	36	1	5	3.28	1.504
The last date of using pesticides	Horizontal Date	36	1	5	4.58	.874
	Dropdown Date	36	1	5	3.42	1.360
Search function	Google Maps	36	1	5	4.19	1.167
	Waze	36	1	5	3.78	1.267
Geolocation Function	Google Maps	36	1	5	4.39	1.022
	Waze	36	1	5	3.61	1.128
Overall design position	Google Maps	36	1	5	4.06	1.372
	Waze	36	1	5	3.81	1.037

4.3. A Comparative Analysis of User Interface Elements

Table 2 shows that the choice of user interface elements can have varying impacts on responses depending on the specific task being performed. For some tasks, certain UI elements did not lead to significant differences in responses based on age or education level. The Picture Radio Button element stood out as having a significant influence on task completion concerning disease name input, while the Drop-down List element was significant for the frequency of pesticide spraying task. On the other hand, several elements, such as Radio Buttons, Image Icons, Text Fields, and Date Pickers, showed consistent task performance across different demographic categories.

Table 2. Comparative analysis based on the task for data entry reporting of chili crop pests and diseases

No.	**List of tasks**	**User interface element**	**Age category Sig.**	**Education level Sig.**
1	The name of the disease	Radio Button	0.411	0.469
		Picture Radio Button	0.870	**0.015**
		Drop-down List	0.128	0.948
		Combo Boxes	0.359	0.302
2	Weather when the report is made	Radio Button	0.377	0.469
		Image Icon	0.208	0.285
3	Estimated number of polybags attacked	Text Field	0.313	0.798
		Drop-down List	0.807	0.907
		Slider	0.320	0.539
4	Frequency of pesticide spraying	Drop-down List	0.585	**0.038**
		Slider	0.168	0.147
5	The last date of using pesticides on crops	Horizontal Date	0.867	**0.029**
		Dropdown Date	0.205	0.318

Asymptotic significances are displayed. The significance level is .05.

Meanwhile, according to Table 3, the findings portray on the influence of specific UI elements in online map services on different user groups. While both Google Maps and Waze demonstrated similar user responses for the search function and overall design position, the geolocation function in Google

Maps seemed to have a significant influence on users' responses depending on their educational background.

The absence of significant differences in several UI elements across demographic categories suggests that both Google Maps and Waze have managed to create user-friendly interfaces accessible to a wide range of users. The slight significance observed in Waze's geolocation function highlights the potential for UI elements to play a role in shaping user experiences based on educational levels, warranting further investigation. As online map services continue to evolve, a deeper understanding of the impact of UI elements on user engagement and satisfaction will be crucial for optimizing these platforms for a broad user base.

Table 3. A comparison of user interface elements between the Google Maps and Waze platforms.

No	**UI in online map services**	**Map medium**	**Age category Sig.**	**Education level Sig.**
1	Search function	Google Maps	0.751	0.270
		Waze	0.426	0.960
2	Geolocation function	GoogleMaps	0.241	**0.021**
		Waze	0.126	0.671
3	Overall design position (particularly on search and geolocation function	Google Maps	0.891	0.972
		Waze	0.671	0.226

Asymptotic significances are displayed. The significance level is .05.

4.4. The Correlation for Task-Based User Interface Test Elements Based on Age Category and Educational Background

The findings from Table 4 explained the complex relationship between age and user interface element preferences. Overall, the study indicated that the young group slightly favored radio buttons and picture radio buttons for disease names, but these differences were not statistically significant ($p > 0.05$) when compared to other age groups. Similarly, no significant age-related differences were found for the radio button and image icon for weather. However, the young group significantly preferred the drop-down list for disease names over the middle-aged group ($p < 0.05$). Conversely, the middle-aged and older adult respondents exhibited similar preferences for combo boxes, drop-down lists for weather, and horizontal date and dropdown date UI elements when inputting data for the last date of pesticide use.

In contrast, the older adult category demonstrated a significantly higher preference for the radio button and image icon for weather compared to the other two age groups. Furthermore, in the geolocation function of Google Maps and Waze, older adults significantly preferred the options more than the young group ($p < 0.05$). These results highlight the varying preferences for specific UI elements across different age groups. While the young group leaned towards drop-down lists, older adults favored radio buttons and image icons. Middle-aged respondents generally shared preferences similar to either young or older adults. However, certain preferences seemed to be more universal, transcending age categories. Therefore, adopting a holistic approach that incorporates a diverse range of design elements catering to users of all ages is essential.

The differences in UI element preferences across age groups result potentially from psychological, cognitive, and experiential influences. These variations are shaped by factors such as cognitive abilities and familiarity with technology, with younger individuals adapting quickly due to early exposure. Visual and interaction preferences also play a role, as younger users favor dynamic visuals while older ones opt for clarity. Lifelong tech experiences impact choices, with younger generations embracing modern interfaces and older adults relying on historical familiarity. Cultural norms, usability, physical skills, cognitive load, and aesthetic preferences contribute to the nuanced landscape of age-related UI preferences. Recognizing these factors is essential for designers to create interfaces that cater to diverse age demographics effectively

Table 4. The correlation between age category on the performance of data entry and online map services tasks.

Ranks				Test Statistics[a,b]		
Age_category		N	Mean Rank	Chi-Square	df	Asymp. Sig.
Disease name Radio Button	Young	12	20.5	1.779	2	0.411
	Middle age	14	15.79			
	Older adult	10	19.9			
Disease name Picture Radio Button	Young	12	19.42	0.28	2	0.87
	Middle age	14	18.39			
	Older adult	10	17.55			
Disease name Drop Down List	Young	12	22.08	4.117	2	0.128
	Middle age	14	14.25			
	Older adult	10	20.15			
Disease name Combo Boxes	Young	12	20.54	2.047	2	0.359
	Middle age	14	15.46			
	Older adult	10	20.3			
Weather Radio Button	Young	12	17.33	1.949	2	0.377
	Middle age	14	16.82			
	Older adult	10	22.25			
Weather Image Icon	Young	12	19.71	3.139	2	0.208
	Middle age	14	15.29			
	Older adult	10	21.55			
Number of polybag attacked Text Field	Young	12	17.42	2.322	2	0.313
	Middle age	14	16.75			
	Older adult	10	22.25			
Number of polybag attacked Drop-down List	Young	12	19.75	0.429	2	0.807
	Middle age	14	17.18			
	Older adult	10	18.85			
Number of polybag attacked Slider	Young	12	18.79	2.277	2	0.32
	Middle age	14	15.71			
	Older adult	10	22.05			
Frequency of pesticide spraying Drop-down List	Young	12	18.5	1.074	2	0.585
	Middle age	14	16.93			
	Older adult	10	20.7			
Frequency of pesticide spraying Slider	Young	12	19	3.572	2	0.168
	Middle age	14	14.93			
	Older adult	10	22.9			
The last date of using pesticides Horizontal	Young	12	18.67	0.285	2	0.867
	Middle age	14	19.14			
	Older adult	10	17.4			
The last date of using pesticides Dropdown	Young	12	17.83	3.17	2	0.205
	Middle age	14	15.75			
	Older adult	10	23.15			
Search function Google Maps	Young	12	17.88	0.572	2	0.751
	Middle age	14	19.96			
	Older adult	10	17.2			
Search function Waze	Young	12	18.04	1.705	2	0.426
	Middle age	14	16.5			
	Older adult	10	21.85			
	Young	12	19.42			

Geolocation function Google Maps	Middle age	14	20.57	2.846	2	0.241
	Older adult	10	14.5			
Geolocation function Waze	Young	12	17.79	4.148	2	0.126
	Middle age	14	15.39			
	Older adult	10	23.7			
Overall design position Google Maps	Young	12	18.25	0.231	2	0.891
	Middle age	14	17.86			
	Older adult	10	19.7			
Overall design position Waze	Young	12	17.13	0.799	2	0.671
	Middle age	14	18.04			
	Older adult	10	20.8			

a. Kruskal Wallis Test, b. Grouping Variable: Age_category

Meanwhile, based on the results shown in Table 5, we can observe intriguing patterns in UI element preferences across different education levels. For the disease name task, it was intriguing to observe that respondents with secondary education showed a preference for the radio button, with a mean rank of 19.50, whereas they ranked the picture radio button lower, with a mean rank of 15.64. In contrast, the pre-university/certificate/diploma/degree group exhibited the opposite pattern, with a higher mean rank of 20.50 for the picture radio button. In the context of the weather input data, the secondary education group displayed a preference for the radio button, with a mean rank of 19.52, while the pre-university/certificate/diploma/degree group favored the image icon, with a mean rank of 20.40. This difference in preference for UI elements between the two education level groups can have significant implications for interface design for pest and disease reporting design. Interestingly, the number of polybag-attacked input data demonstrated similar preferences for both education level groups across different UI elements, suggesting that this particular application type may have elements that are equally appealing to individuals with different educational backgrounds.

Another noteworthy finding was observed in the geolocation function, where the secondary education group favored the waze (mean rank: 19.10), while the other group preferred google maps (mean rank: 22.60). This discrepancy in UI element preference indicates that the choice of mapping features may vary depending on the user's education level, highlighting the importance of tailoring such applications to specific user groups. These findings suggest that distinct cognitive styles, information processing capabilities, and technological familiarity associated with different educational backgrounds may influence how users prioritize features in various applications. Individuals with a higher education level (Pre-university/Certificate/Diploma/Degree) may exhibit a greater familiarity with technology and possess a more nuanced understanding of digital interfaces. This heightened familiarity could lead them to prefer different features compared to their counterparts in secondary education, who might have a different approach to interacting with digital applications.

Therefore, the differences in UI element preferences across education levels stem can occur from a combination of cognitive, experiential, and cultural factors. Higher education levels often signify better cognitive abilities and familiarity with technology, leading individuals to prefer more complex and modern UI elements. These users might have higher expectations for advanced interfaces due to their exposure to modern design trends and critical thinking skills. Conversely, individuals with lower education levels might opt for simpler, more intuitive designs that align with their experiences and processing capabilities. These differences highlight the need for all parties involved to consider these factors to create interfaces that accommodate various education backgrounds, ensuring usability and meeting users' cognitive preferences. Overall, the variations in UI preferences driven by education levels underscore the role of cognitive abilities, technological familiarity, and cultural influences in shaping user interactions with digital interfaces.

Table 5. Correlation analysis for data entry and online map services tasks based on education level.

Ranks					**Test Statistics**[a]				
Education_level		N	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)	Exact Sig. [2*(1-tailed Sig.)]
Disease name Radio Button	1	21	19.50	409.50	136.500	256.500	-.725	.469	.505[b]
	2	15	17.10	256.50					
Disease name Picture Radio Button	1	21	15.64	328.50	97.500	328.500	-2.443	**.015**	.053[b]
	2	15	22.50	337.50					
Disease name Drop-down List	1	21	18.60	390.50	155.500	275.500	-.066	.948	.948
	2	15	18.37	275.50					
Disease name Combo Boxes	1	21	19.98	419.50	126.500	246.500	-1.031	.302	.324[b]
	2	15	16.43	246.50					
Weather Radio Button	1	21	19.52	410.00	136.000	256.000	-.724	.469	.505[b]
	2	15	17.07	256.00					
Weather Image Icon	1	21	17.14	360.00	129.000	360.000	-1.069	.285	.374[b]
	2	15	20.40	306.00					
Number of polybag attacked Text Field	1	21	18.17	381.50	150.500	381.500	-.257	.798	.825[b]
	2	15	18.97	284.50					
Number of polybag attacked Drop-down List	1	21	18.33	385.00	154.000	385.000	-.116	.907	.924[b]
	2	15	18.73	281.00					
Number of polybag attacked Slider	1	21	19.38	407.00	139.000	259.000	-.615	.539	.568[b]
	2	15	17.27	259.00					
Frequency of pesticide spraying Drop-down List	1	21	15.93	334.50	103.500	334.500	-2.077	.038	.083[b]
	2	15	22.10	331.50					
Frequency of pesticide spraying Slider	1	21	20.60	432.50	113.500	233.500	-1.451	.147	.160[b]
	2	15	15.57	233.50					
The last date of using pesticides Horizontal	1	21	16.05	337.00	106.000	337.000	-2.179	**.029**	.102[b]
	2	15	21.93	329.00					
The last date of using pesticides Dropdown	1	21	19.93	418.50	127.500	247.500	-.998	.318	.340[b]
	2	15	16.50	247.50					
Search function Google Maps	1	21	17.02	357.50	126.500	357.500	-1.103	.270	.324[b]
	2	15	20.57	308.50					
Search function Waze	1	21	18.57	390.00	156.000	276.000	-.051	.960	.975[b]
	2	15	18.40	276.00					
Geolocation function Google Maps	1	21	15.57	327.00	96.000	327.000	-2.312	**.021**	.049[b]
	2	15	22.60	339.00					
Geolocation function Waze	1	21	19.10	401.00	145.000	265.000	-.424	.671	.704[b]
	2	15	17.67	265.00					

Overall design position Google Maps	1	21	18.45	387.50	156.500	387.500	-.036	.972	.975[b]
	2	15	18.57	278.50					
Overall design position Waze	1	21	16.81	353.00	122.000	353.000	-1.210	.226	.265[b]
	2	15	20.87	313.00					

**Note: 1= Secondary Education, 2 = Pre-university/Certificate /Diploma/Degree;* a. Grouping Variable: Education_level, b. Not corrected for ties.

4.5. The Impact of Age and Education Level on Usability and Experience

The task-based user interface testing with age category and education level reveals that certain UI elements for both age and education level significantly impact user performance and preferences when interacting with the interface. The study emphasizes the importance of considering users' age and education level in interface design to ensure usability and a positive user experience. Tailoring the interface to accommodate users with varying levels of digital literacy and technical proficiency is crucial for achieving high usability and satisfaction. Additionally, the study highlights the significance of adopting a user-centric design approach, where the interface is designed with consideration for the diverse needs and capabilities of users from different age and education groups. Implementing features like clear instructions, intuitive navigation, and adjustable settings can enhance usability for users of all ages and educational backgrounds.

Moreover, the study indicates that older users and those with lower education levels may benefit from additional training and support to enhance their interaction with the interface. Providing accessible resources, tutorials, or help features can empower users to overcome potential barriers and improve their overall experience. Furthermore, designing interfaces with customizable elements can further accommodate users of different age categories and education levels. Allowing users to tailor the interface to their preferences enhances usability and fosters a sense of inclusivity.

Given the dynamic nature of technology and user needs, continuous evaluation and iterative design processes are essential. Regularly assessing the interface's usability with representative users from various age and education groups can identify areas for improvement and inform necessary updates to maintain user satisfaction. Based on this study, the task-based user interface testing with age category and education level highlights the significance of considering demographic factors in interface design. A user-centric design approach, coupled with ongoing evaluation and updates, can lead to interfaces that effectively meet the needs of users across age and education spectrums, ultimately enhancing the overall user experience.

5. Conclusion

This study underscores the importance of thoughtful user interface design, considering both age and education levels of users. It also provides valuable insights for researchers and UI developers in creating user-friendly mobile applications, particularly for reporting pests and diseases using location-based mobile applications. The findings contribute to a better understanding of the impact of UI elements on task performance, allowing all parties involved to optimize interface layouts to enhance user experiences.

Understanding user preferences and the impact of different UI elements on task performance and user satisfaction can lead to more inclusive and optimized platforms that resonate with a broad user base. As technology continues to evolve, continuous research and a user-centric approach will be crucial in delivering enhanced user experiences in digital applications that are tailored to the diverse needs of various user demographics.

Further study could conduct a more extensive investigation into user demographics and examine how these design UI elements might influence the overall user experience and effectiveness of applications, for example, assessing user experience when utilizing mobile location-based services for crop pest and disease reporting. Despite the insightful results, the study acknowledges its limitations, such as restricted sample size and potentially biased respondent selection. Nevertheless, the study also acknowledges the need for further research to explore additional factors that could influence these relationships and to generalize the findings to larger and more diverse populations. Understanding these factors will enable the development of more effective and inclusive agricultural applications, contributing to improved farming practices and outcomes.

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