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### A DIGITAL SOLUTION FOR AGRICULTURE: BUILDING A DEMAND AND SUPPLY (D&S) PORTAL FOR MONITORING AGRICULTURAL PRODUCTS

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#### ABSTRACT

This study addresses these challenges by exploring the issues faced by the agriculture industry, particularly the need for marketing information, difficulties in reaching potential purchasers, and the need for effective marketing strategies. However, effectively managing this sector's complex supply and demand dynamics presents substantial challenges. The primary objective of this research is to develop a user-friendly agriculture portal called a Demand and Supply (D&S) Portal that empowers small-scale farmers to make informed decisions about marketing their products. The Agile methodology guides the development of this portal, ensuring flexibility, adaptability, and iterative development. The research process incorporates rigorous literature reviews and problem recognition as foundational steps before system development. The evaluation of the portal indicates high user satisfaction. Respondents found the portal's features for managing and monitoring agricultural product demand and supply straightforward and valuable. The portal's usability and efficiency were well-received, with users expressing their intention to recommend it to others. It serves as a reference model for developers and researchers in the agricultural sector, offering valuable insights into demand and supply management. Future enhancements include optimising the portal for mobile use, incorporating product images and pricing information, and enhancing security features. The D&S Agri Portal is a promising tool for empowering small-scale farmers and improving the efficiency of agricultural transactions. Continuous user feedback and technological adaptations will enhance its usability and effectiveness in facilitating agricultural demand and supply management. This research contributes to understanding the agriculture industry's challenges and the potential solutions to address them. It also highlights the importance of empowering small-scale rural farmers through effective marketing platforms.

**Keywords:** Agriculture portal, supply-demand and supply, online digital solution, market efficiency.

## **INTRODUCTION**

Agriculture, stemming from the Latin term "Agricultura", which signifies land cultivation, transcends linguistic origins. It serves as humanity's sustenance lifeline and a catalyst for global economic advancement (Pandey et al., 2022). As the primary source of essential food and commodities, agriculture upholds global food security and maintains societal stability. The prosperity of nations is inextricably linked to the progress of their agricultural sectors (Abate et al., 2018). As Pandey et al. (2022) highlighted, recent research underscores the critical importance of integrating state-of-the-art technology in advancing agriculture. Cutting-edge technologies, ranging from image processing to precision agriculture and smart farming, have the potential to reshape traditional agricultural practices, leading to significant improvements in productivity. With these tools, farmers can allocate resources more efficiently, closely monitor crop health, and make data-driven decisions, all contributing to enhanced crop yields.

Moreover, as Hafiz et al. (2021) pointed out, social media platforms have transformed how farmers exchange insights and information. This heightened connectivity and knowledge-sharing environment have created virtual communities where farmers actively learn about the latest methodologies, market dynamics, and technological advancements. Such interactions foster continuous improvement within the agricultural community. However, it is essential to recognise that not all farmers readily embrace these innovative technologies, as noted in the study by Kumar and Ilango (2018). This resistance to change often leads to the continued use of conventional methods, which can limit overall agricultural productivity. Bridging the gap between traditional practices and modern technology is imperative to fully unlock the potential of agricultural resources.

Considering these recent advancements and challenges in agriculture, this study explores how innovative technologies, including image processing, precision agriculture, and social media platforms, can amplify agricultural productivity and catalyse economic expansion. The paper will delve into the consequences, challenges, and possibilities associated with integrating these technologies into agriculture, shedding light on technology's transformative potential in shaping this critical domain's future. The following sections will examine these aspects in-depth, contributing to the broader understanding of technology's role in agriculture.

## **RELATED WORK**

The agricultural landscape in Malaysia plays a crucial role in addressing global food demand and supplying diverse agricultural products. This demand is influenced by many factors, including the steady rise in the worldwide population, evolving dietary preferences, and economic growth (FAO, 2017). As the world's population continues to grow, there is an ever-increasing need for sustenance, with predictions indicating a substantial increase in demand in the years ahead. Additionally, the economic prosperity witnessed in emerging economies has led to shifts in dietary choices, with a preference for protein-rich foods and a broader range of agricultural offerings (FAO, 2017).

The challenge of meeting the surging demand for agricultural commodities necessitates the establishment of an efficient and resilient agricultural supply chain. This intricate network encompasses various activities, ranging from cultivation and processing to distribution and marketing of agricultural products. Amid this complex landscape, technological innovations have emerged as a transformative force, enhancing productivity, streamlining supply chain operations, and creating new pathways for market entry (Pandey et al., 2022).

In recent years, Malaysia's agricultural sector has undergone a significant transformation driven by technological advancements, particularly the adoption of Smart Farming technologies powered by the Internet of Things (IoT) (Wee et al., 2020). Smart Farming has gained prominence in paddy fields, witnessing a substantial increase in adoption rates. Farmers seamlessly integrate Smart Farming tools with IoT sensors and data analytics capabilities. This integration enables real-time data collection and analysis, encompassing crop health, soil conditions, and meteorological trends. With this wealth of information, farmers can make data-informed decisions, optimising resource allocation and embracing sustainable farming practices.

However, the successful integration of technology into agriculture hinges on financial resources and farmers' technical competence and knowledge (Mutyasira et al., 2018). Education and training initiatives are pivotal in equipping farmers with the necessary skills to embrace and harness modern farming technologies effectively. These programs serve as enablers, enhancing farmers' understanding of the benefits and functionalities inherent in technological tools. By empowering farmers with this knowledge, they can unlock the full potential of the resources at their disposal.

Furthermore, education bridges the digital divide, particularly in rural areas, by providing farmers with essential digital literacy skills (Zheng et al., 2019). This proficiency ensures that farmers, especially those in rural landscapes, are equipped with the critical digital skills needed to harness technology in agriculture. In this context, education removes barriers and empowers farmers to leverage technology as a catalyst in their agricultural journey.

The harmonious integration of technological advancements and tailored education holds the promise of elevating the productivity and sustainability of Malaysia's agricultural sector. Equipping farmers with the knowledge and skills to employ modern farming technologies adeptly enhances their yields and contributes to the overall advancement of the agricultural domain. Additionally, engaging and involving rural youth in agriculture is crucial for its continued vitality and expansion. However, the sector needs help attracting and retaining young individuals who often opt for urban careers due to perceived challenges and a lack of prestige associated with farming (Girdziute et al., 2022). Recognising the transformative potential of rural youth in agricultural development and food security, concerted efforts must be directed toward making the industry an appealing and economically promising frontier.

Encouraging entrepreneurship, fostering innovation, and embracing technological advancements within agriculture offers many opportunities. These initiatives highlight the potential for growth and profitability and create an appealing narrative that attracts the younger generation to explore rewarding careers in agriculture (Geza et al., 2021). Engaging youth across the agricultural value chain, including processing, packaging, and marketing, aligns with their interests and ambitions. Such active participation provides them with meaningful roles and exposes them to the multifaceted aspects of the agricultural business, igniting their desire to contribute to its transformation.

Islam et al. (2022) emphasised the pivotal role of promoting agricultural education and training programs. These initiatives serve as crucibles for nurturing young minds equipped with the essential skills and knowledge required for success in the agricultural sector. This educational journey instils a deep understanding of agricultural methodologies, sustainable farming practices, and the intricacies of market trends. With this competency, young individuals transition into formidable contributors, driving the sector's growth, innovation, and resilience. The focal point now shifts to engaging and empowering rural youth. This concerted effort can cultivate a new generation of farmers and agricultural visionaries. Through initiatives championing entrepreneurship, technological adoption, and education, the sector

can address the challenge of attracting and retaining youthful talent, creating a promising and sustainable agricultural future. In Malaysia, many demand and supply portals have emerged to facilitate the seamless exchange of agricultural goods and knowledge among farmers, traders, and consumers. These digital platforms weave a narrative of connectivity, effectively linking the distinct stakeholders of the agricultural supply chain, thus promoting transparency and accessibility. Notable among these portals are detailed in Table 1.

The demand and supply portals within Malaysia's agricultural landscape play pivotal roles, orchestrating a symphony that resonates with numerous benefits. These digital platforms go beyond mere functionality, serving as catalysts for transformative changes. Key among these transformations are expanding market access for farmers, strengthening mechanisms for price discovery, and establishing transparency within the agricultural supply chain. Farmers broaden their market horizons by strategically utilising these digital platforms. Simultaneously, the intricacies of sales processes are simplified, leading to fairer prices for their produce. These portals also enhance the convenience of consumers, offering a wide array of agricultural products characterised by quality and authenticity, thereby redefining the consumer experience. Essentially, these portals empower agricultural producers and consumers, fostering fairness, transparency, and accessibility within the agricultural ecosystem.

**Table 1**

*List of Websites for Managing and Monitoring the Demand and Supply of Agriculture Products*

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Related Studies	Description
Agrobazaar Malaysia	Agrobazaar Malaysia is a virtual crossroads, a digital agora seamlessly interlinking farmers and consumers. This online marketplace is a conduit for a sprawling array of agricultural offerings. Rooted in the essence of connectivity, this platform orchestrates an interface where farmers unfurl their wares for public view, and consumers partake in a direct tango with freshly harvested bounty.
Malaysian Agricultural Research and Development Institute (MARDI)	MARDI, the vanguard of agricultural research in Malaysia, emerges as a beacon illuminating the path of innovation. Within their virtual domain, a reservoir of knowledge awaits—a glimpse into their pioneering research pursuits, cutting-edge technologies, and revolutionary advancements within agriculture. Their digital threshold opens doors to a treasure trove of scientific publications, a gateway to training initiatives, and a wellspring of resources tailored for the agricultural fraternity. MARDI's digital landscape is a haven where the agricultural community finds nourishment—a realm where insights flourish, and the future of agriculture takes root.
Agri Malaysia	Agri Malaysia emerges as a digital conduit, a virtual portal curating a tapestry of agricultural news, market dynamics, and a wealth of resources catering to farmers and agribusinesses. This online expanse embraces an expansive canvas, brushing strokes across diverse domains—ranging from the nuances of crop cultivation and the intricacies of livestock farming to the symphonies of agro-tourism and the technological symposiums within agriculture.

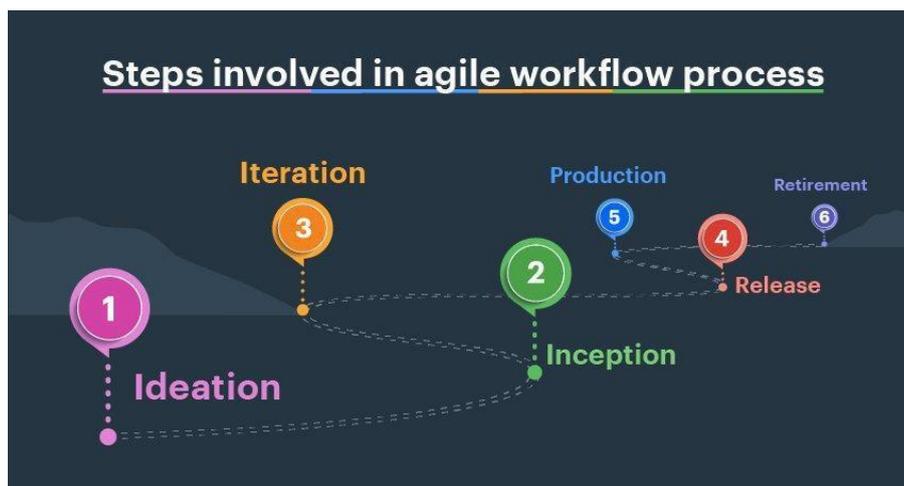
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## METHODOLOGY

The research methodology employed in this study encompasses the Agile methodology as the chosen approach for system development. The survey by Al-Saqqa et al. (2020) defined agile methodology as well-known for its capacity to reduce unnecessary bureaucracy in software development while facilitating flexible adjustments without disrupting the work process or requiring unwarranted revisions. Figure 1 illustrates the sequence of these phases, providing a visual representation of the process flow. While this methodology predominantly addresses the system development process, it is essential to delineate the methods used for the literature review and the recognition of the need to develop the new system.

**Figure 1**

*The Phases of Agile Methodology*



The literature review process was conducted systematically to gain a comprehensive understanding of the existing agricultural market challenges, the limitations of current systems, and the opportunities for improvement. A thorough search was performed using academic databases and search engines, employing keywords such as "agriculture industry challenges," "demand and supply management," and "digital agricultural platforms." Pertinent articles, research papers, and reports were scrutinised to extract relevant insights and findings. The synthesis of this literature informed the identification of gaps in the current agricultural landscape, which subsequently contributed to the recognition of the need for a new system.

The need to develop the D&S Agri Portal was recognised through a careful examination of the challenges faced by the agriculture industry. The literature review highlighted issues such as a need for more marketing information, difficulties in reaching potential purchasers, and the need for effective marketing strategies. These challenges were reinforced by real-world scenarios and experiences shared by small-scale farmers and stakeholders in the agriculture sector. This recognition was further bolstered by insights from experts in the field, underscoring the potential impact of an efficient demand and supply management system.

Therefore, while the Agile methodology primarily guides the system development process, the research methodology encompasses a systematic literature review and critically recognises the need for the D&S Agri Portal based on a deep understanding of agricultural challenges and opportunities.

## DESIGN AND DEVELOPMENT

This section outlines the design and development of a website to monitor the demand and supply of agricultural products, aligning with the initial three phases of Agile methodology. The section is further divided into two sub-sections for clarity: (1) the website's requirements for creating and managing agricultural product demand and supply, and (2) the development of a prototype called D&S Agri Portal, which serves as a demonstration of the identified requirements.

The process of gathering requirements for the website involved two distinct methods. First, informal discussions with the supervisor emphasised the determination of essential website functions. These conversations allowed for the exchange of opinions and feedback, ultimately leading to a consensus on the procedures to be integrated.

Throughout the construction phase, both parties actively engaged in the process. The prototype interface was presented to elicit feedback and comments from all stakeholders, ensuring that the development process integrated the perspectives of both the supervisor and authors. In the secondary requirements gathering process, relevant documents were meticulously researched using the Google search engine, with keywords like "agriculture portal," "agriculture demand and supply," and "demand and supply portal." A thorough analysis of these documents identified specific requirements for developing a website that effectively monitors agricultural product demand and supply. Table 2 briefly presents the four significant needs and their priorities from these supplementary requirements-gathering processes. These requirements encompass new user registration, login functionality, product management for agricultural products, viewing product details, completing the demand form, and accessing information regarding product demand and supply.

**Table 2**

*List of Requirements for Managing and Monitoring Demand and Supply of Agriculture Products*

ID	Requirement Description	Priority
1	REGISTER	
1.1	The system will allow users to register before logging into DSAP.	Mandatory
1.2	The system must display a page that allows user to choose their site login detail: i. Register ii. Login	Mandatory
1.3	The system must display a page that allows the user to key in their details: i. User Type ii. userID/admin iii. Name iv. Email v. Phone Number vi. userPassword/adminPassword	Mandatory

1.4	The user can cancel the registration anytime by clicking the “Cancel” button.	Optional
2	LOGIN	
2.1	The system will enable the user to choose their user type:	Mandatory
	i. Member	
	ii. Admin	
2.2	The user is required to log in using their ID and password.	Mandatory
2.3	The system will prompt an error message such as “Invalid Login” if the user inputs the wrong ID and password.	Mandatory
2.4	The user can click “Forgot Password” to reset the password.	Optional
3	MANAGE PRODUCT	
3.1	Users can add the product details.	Mandatory
3.2	Users can edit the product details.	Desirable
3.3	Users can delete all the product details.	Desirable
4	VIEW PRODUCT DETAILS	
4.1	The system can display the product by the categories.	Desirable
4.2	Users can search for product details.	Desirable
5	FILL DEMAND FORM	
5.1	The system will display demand form	Mandatory
5.2	User can fill in a demand form based on their demand for the product	Desirable
6	VIEW PRODUCT DEMAND AND SUPPLY	
6.1	The system will generate the product demand and supply.	Mandatory
6.2	Users can view the product demand and supply.	Mandatory

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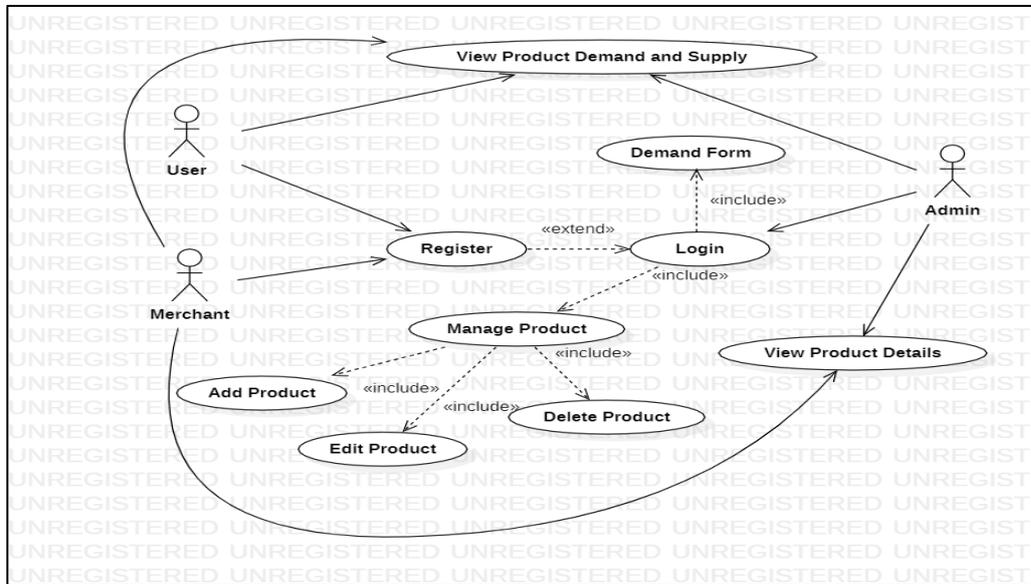
The requirements in Table 2 were translated into computer system functionality. The next step involves visualising and modelling the website requirements using the Unified Modeling Language (UML). In this study, we employed UML to create two behavioural diagrams, use case and activity diagrams, and a class diagram representing the app's structural components. StarUML was used to draw these diagrams. Figure 2 illustrates the use case diagram, depicting interactions between use cases and actors for the portal designed for creating and managing agricultural products to monitor demand and supply. Six prominent use cases were identified: registration, login, product management, product details viewing, demand form filling, and product demand and supply viewing.

The "Manage Product" use case allows users to perform subfunctions such as "Add Product," "Edit Product," and "Delete Product." "View Product Details" enables users to "Display product details" and

"Search Product." "Fill Demand Form" allows users to "submit demand based on their product needs," and "View Product Demand and Supply" permits users to "review product demand and supply."

**Figure 2**

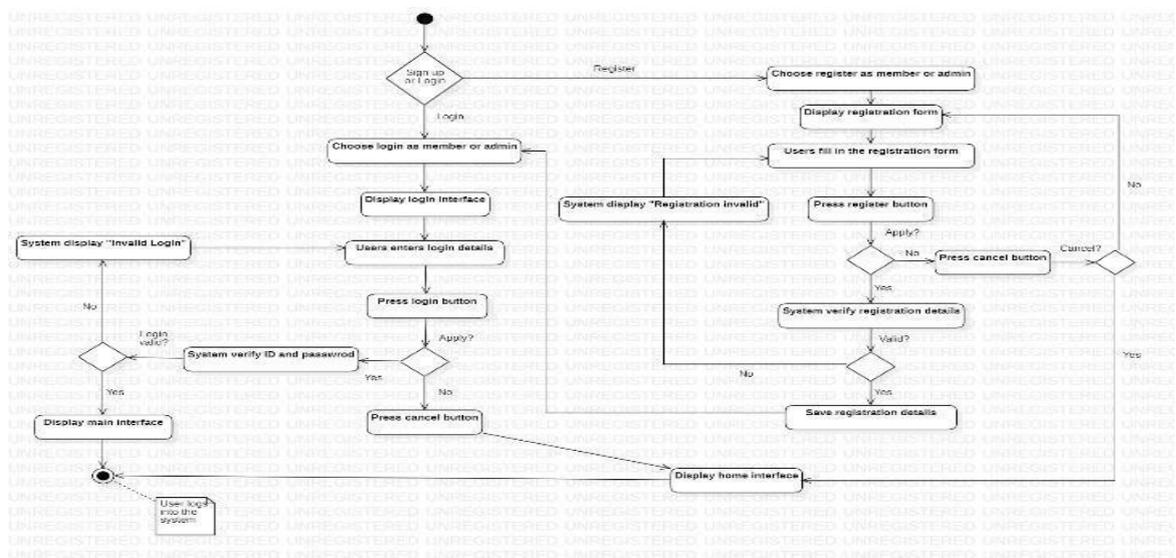
*The Use Case Diagram of the Website for Managing and Monitoring Agriculture Product Demand and Supply*



The use case diagram is detailed to show the dynamic behaviour of the website. Hence, the operations involved in using the website for managing and monitoring the demand and supply of agriculture products are illustrated in an activity diagram of Figure 3, which is self-explanatory.

**Figure 3**

*The Activity Diagram of the Website for Managing and Monitoring Agriculture Product Demand and Supply*

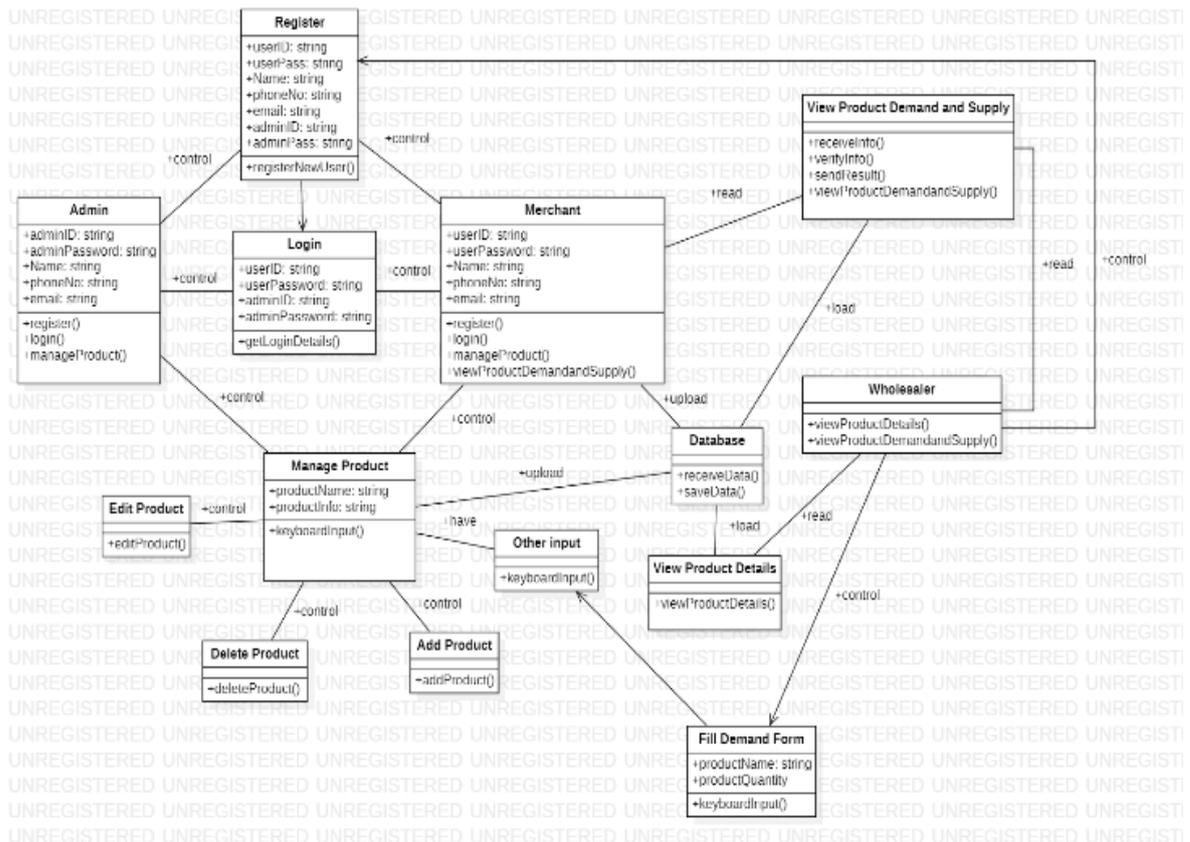


The structural components of a website for managing and monitoring the demand and supply of agricultural products are represented in a class diagram, as illustrated in Figure 4. The class diagram in

Figure 4 shows the attributes and operations of the website. This work identified four main classes: user, merchant, admin, manage product, view product details, fill demand form, and view product demand and supply. The interactions between the classes are illustrated clearly in the diagram.

**Figure 4**

*The Class Diagram of the Website for Managing and Monitoring Agriculture Product Demand and Supply*



## D&S AGRI PORTAL PROTOTYPE DEVELOPMENT

A prototype of a website for monitoring the demand and supply of agricultural products was developed, incorporating the requirements outlined in the previous subsection. Visual Studio Code was the primary integrated development environment (IDE) tool. Furthermore, web hosting enabled essential functions such as user authentication and database for data storage, ensuring public accessibility. Screenshots in Figures 5 and 12 show the selected interfaces of the D&S Agri Portal.

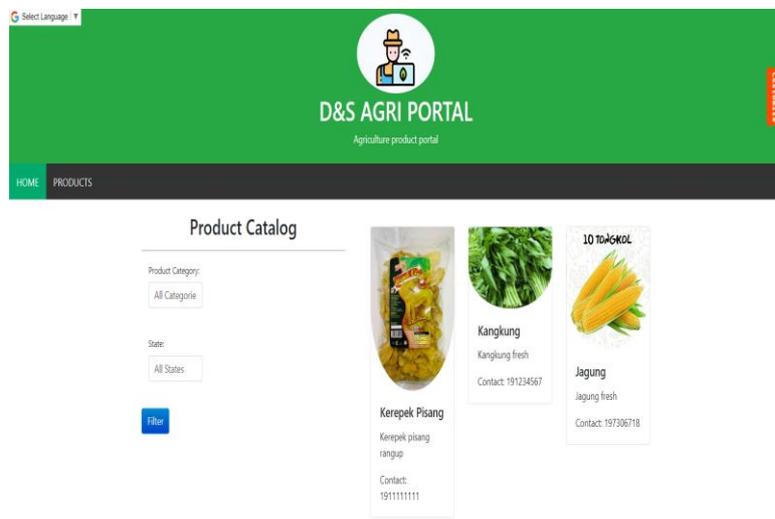
**Figure 5**

*Home Page of D&S Agri Portal*



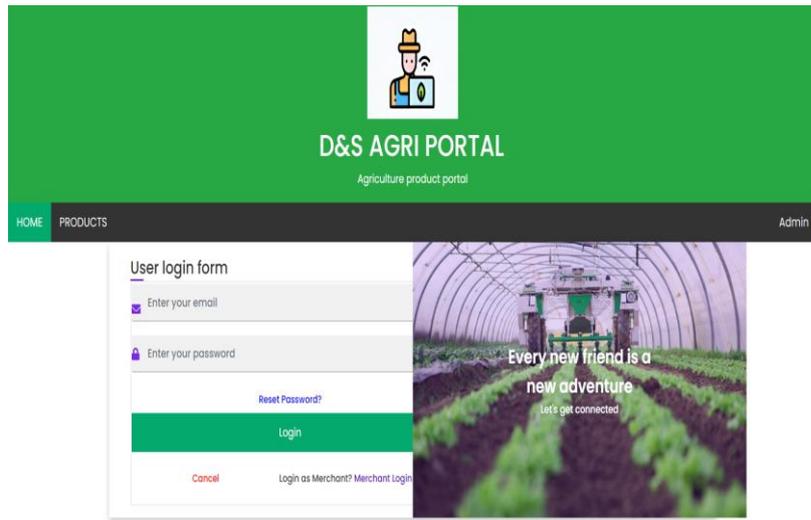
**Figure 6**

*Product details page of D&S Agri Portal*



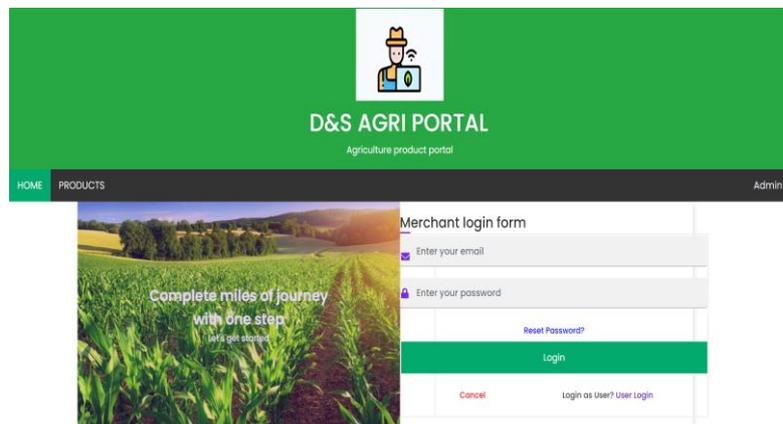
**Figure 7**

*User login interface.*



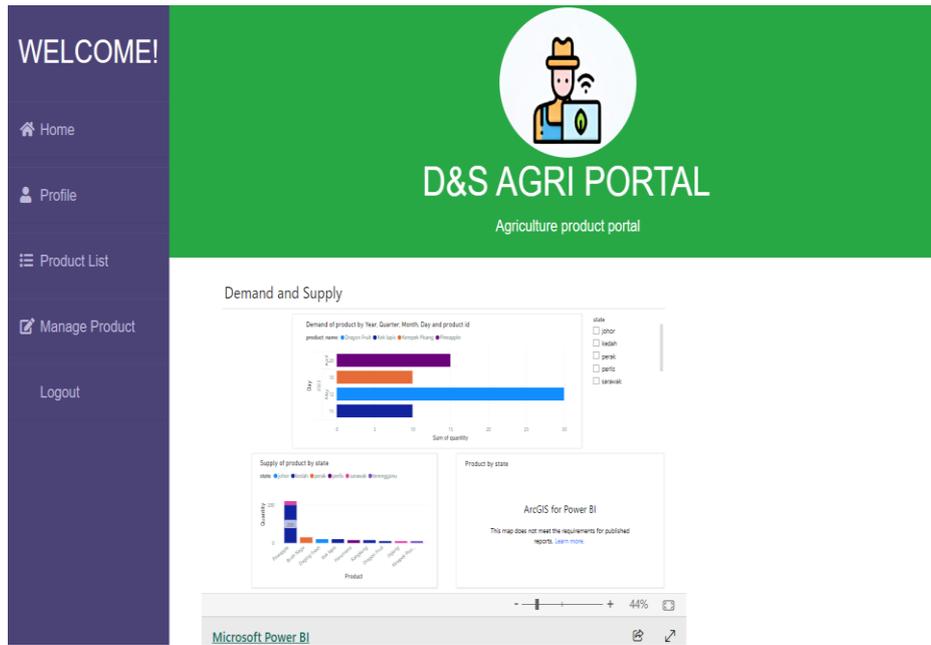
**Figure 8**

*Merchant login interface.*



**Figure 9**

Home interface after successful login.



**Figure 10**

User profile interface.

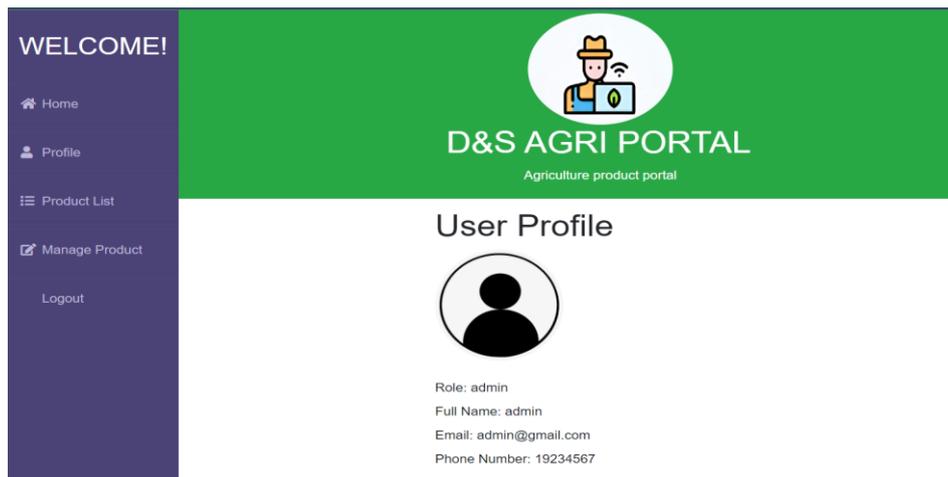


Figure 11

Manage product interface

**PRODUCTS**

PRODUCT NAME  
PRODUCT NAME

PRODUCT CATEGORY  
Fruits

UNIT  
UNIT

PRODUCT DESCRIPTION  
PRODUCT DESCRIPTION

DATE: 10/04/2023

CONTACT INFO  
CONTACT INFO

STATE  
Choose State:

PRODUCT IMAGE  
Choose File No file chosen

Add Cancel

Figure 12

List of product interfaces.

**List of Products**

Product Name	Product Category	Quantity	Description	Contact	Image	Action
Pineapple	fruits	50	fresh	1978900000		<a href="#">Edit</a> <a href="#">Delete</a>
Kek lapis	agro-based	10	Kek lapis dari Sarawak	197306718		<a href="#">Edit</a> <a href="#">Delete</a>

## ANALYSIS AND RESULTS

A usability evaluation was conducted with 30 respondents, comprising both the public and university students in Malaysia. Respondents were selected through essential random sampling and interacted with the D&S Agri Portal website, followed by a post-task questionnaire.

The questionnaire had five sections: Section A collected demographic information, Section B assessed the portal's ease of use using a Likert scale, Section C evaluated efficiency with a combination of Likert scale and yes/no/maybe options, Section D measured overall satisfaction similarly, and Section E allowed for feedback and suggestions. The sample included 17 members from the public and 13 university students, with 23 females and seven males. Most respondents (57%) were aged 18-25, and technological expertise varied, with 43% considering themselves intermediate. About 53% had no prior experience with similar systems, while 30% had some exposure. The analysis of responses in Section B showed that the majority rated usability aspects with scores of four or five, with only a few giving lower ratings or expressing neutrality.

**Table 3**

*The Respondents' Responses on the Ease of Use of D&S Agri Portal*

The post-task questionnaire items	Scale 1	Scale 2	Scale 3	Scale 4	Scale 5	Average
How easy was it to navigate through the D&S Agri Portal?	0 (0.00)	0 (0.00)	5 (17.00)	13 (43.00)	12 (40.00)	4.23
Please rate the overall user-friendliness of the D&S Agri Portal.	0 (0.00)	0 (0.00)	5 (17.00)	13 (43.00)	12 (40.00)	4.23
To what degree did you encounter any obstacles or difficulties while using the D&S Agri Portal?	0 (0.00)	0 (0.00)	5 (17.00)	13 (43.00)	12 (40.00)	4.23
Overall, how would you rate the ease of use of the D&S Agri Portal?	0 (0.00)	0 (0.00)	5 (17.00)	13 (43.00)	12 (40.00)	4.23

**Table 4**

*The Respondents' Responses on The Efficiency of D&S Agri Portal*

The post-task questionnaire items	Scale 1	Scale 2	Scale 3	Scale 4	Scale 5	Average
How efficient was the system in helping you accomplish your tasks?	0 (0.00)	0 (0.00)	0 (0.00)	12 (52.00)	11 (48.00)	3.43
How satisfied were you with the speed and responsiveness of the system?	0 (0.00)	1 (4.00)	1 (4.00)	9 (32.00)	17 (61.00)	4.20

**Table 5**

*The Respondents' Responses on Their Satisfaction of D&S Agri Portal*

The post-task questionnaire items	Scale 1	Scale 2	Scale 3	Scale 4	Scale 5	Average
How satisfied were you with your overall experience using the system?	0 (0.00)	0 (0.00)	0 (0.00)	15 (58.00)	11 (42.00)	3.83
How likely are you to continue using the system in the future?	0 (0.00)	0 (0.00)	5 (17.00)	13 (43.00)	12 (40.00)	4.23
How would you rate the system compared to similar ones you have used?	0 (0.00)	0 (0.00)	4 (13.33)	16 (53.33)	10 (33.33)	4.20

The evaluation results underscore the significant value and user-friendliness of the D&S Agri Portal, particularly when compared to existing agricultural portals in Malaysia. Respondents exhibited high satisfaction with its features for managing and monitoring agricultural product demand and supply, highlighting substantial improvements over existing systems. Feedback analysis revealed that most respondents found every portal function straightforward and highly beneficial, marking a notable advancement over the complexities of some existing portals. They perceived the D&S Agri Portal as an effective and user-friendly tool for managing their demand and supply preferences, representing an apparent enhancement in usability compared to similar platforms in the Malaysian agricultural landscape. In terms of efficiency, respondents reported that the D&S Agri Portal was remarkably user-

friendly, even without the need for written instructions. This ease of use allowed them to navigate the platform seamlessly, ensuring efficient task completion a significant departure from some existing portals that can be cumbersome and require additional guidance. Furthermore, respondents were content with the website's overall usability, indicating a notable improvement compared to their experiences with other agriculture-related websites. They also firmly intended to recommend the D&S Agri Portal to others, signalling its potential as a benchmark for user-friendly and efficient demand and supply management platforms in the Malaysian agricultural sector.

## **CONCLUSION**

In conclusion, this paper has outlined the design and development of the D&S Agri Portal, a prototype website to enhance agricultural demand and supply management. The portal represents a significant advancement in streamlining agricultural transactions, promoting transparency, and connecting stakeholders in the industry. The D&S Agri Portal offers a user-friendly interface, real-time market data, and advanced communication tools, making it a comprehensive solution for optimising agricultural transactions. It acts as a digital hub connecting farmers, traders, and consumers, facilitating the exchange of agricultural products. The portal's secure payment options and quality assurance mechanisms build trust and reliability in agricultural transactions. Furthermore, the D&S Agri Portal serves as a reference model for developers and researchers in the agricultural sector. It provides insights into effective demand and supply management, offering a valuable tool for enhancing market efficiency, fair pricing, and seamless transactions.

There are several areas for potential improvement and expansion of the D&S Agri Portal. Firstly, optimising the portal for smartphone use is crucial, given the increasing use of mobile devices. Product images and pricing information in the demand form can enhance user engagement. Implementing password strength suggestions and reviewing the inclusion of contact numbers for each product in the catalogue are also crucial for user privacy and efficiency. Addressing these areas in future development will enhance the portal's usability, user engagement, and security. Continuous efforts to gather user feedback and adapt to technological advancements will contribute to the portal's effectiveness in facilitating agricultural transactions and providing a seamless and secure user experience.

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