Model for Responsive Agriculture Hub via e-Commerce to Sustain Food Security

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***Abstract*—Ensuring food security in the face of evolving environmental, economic, and societal challenges requires innovative solutions that leverage emerging technologies. This paper proposes a model for a responsive agriculture hub facilitated through e-commerce platforms to address the dynamic demands of food production, distribution, and consumption. The model integrates data-driven decision-making, supply chain optimization, and digital marketplaces to enhance the efficiency and resilience of agricultural systems. By harnessing real-time data analytics, predictive algorithms, and smart logistics, the proposed hub enables agile responses to fluctuating market conditions, climatic variability, and resource constraints. Through case studies and simulation analyses, we demonstrate the effectiveness of the model in enhancing the accessibility, affordability, and sustainability of food systems. Furthermore, we discuss the implications of this approach for stakeholders across the agricultural value chain, including farmers, distributors, retailers, and consumers. The findings underscore the potential of leveraging e-commerce platforms as catalysts for transformative change in agriculture, contributing to the overarching goal of achieving food security in an increasingly uncertain world.**

Keywords*—*Digital agriculture hub model; digital value chain; responsive agriculture hub; food security; multi-sided e-commerce

I. Introduction

Agriculture has contributed significantly to food security worldwide. Malaysia National Agro-food Policy (2011-2020) focused on ensuring adequate food supply and safety, developing the agro-food industry into a competitive and sustainable industry, and increasing the income level of agricultural entrepreneurs [1]. The agriculture sector used to be one of the main economic activities contributing to the country's Gross Domestic Product (GDP). However, since 1990 due to the emergence of the manufacturing industry in Malaysia, the agriculture sector has been slowing down. The contribution of the agriculture sector in Malaysia decreased from 28.8% in 1970 to only 7.4% in 2020 to the overall GDP [2].

Furthermore, with the wave of COVID-19, agriculture as well having its drawbacks which affected worldwide trade for both supply and demand. In 2020, the imported goods from agriculture were higher than the exported goods. Although some goods need to be imported, the amount of imported goods in 2020 is higher than the previous years. Such increment of imported goods with export reduction may lead to the increase of food trade deficit which will cause a lower GDP as there is less production made within the country. It might take up to the point where the domestic currency weakens and causes deflation. The performance of the agriculture sector in Malaysia's GDP dropped to 7.1% in 2021 [3].

Food insecurity is a worldwide issue and it has become an alarming phenomenon occurred in Malaysia. The definition of food insecurity by the United States Department of Agriculture (USDA) is a lack of consistent access for people to obtain sufficient food to live an active and healthy life. Millions of world populations are starving and they cannot manage to feed themselves sufficiently. However, food insecurity is not only meant by access to enough food quantitatively but also by obtaining nutritious and healthy food in our daily lives. This food insecurity issue can have a variety of huge impacts on all groups of people including consumers and farmers in terms of health, economy and environment. Food security is important for having sufficient food to consume as well as the quality of food and the value chain of food globally. Consequently, lack of food security is related to conflict, civil strife, poverty, and starvation can all result from a lack of food security. In addition, ensuring food security is critical due to the rise of climate change and global population, as well as supply chain disruptions like the pandemic.

Modernising the agriculture sector is necessary by adopting various technologies from previous centuries and generations. The growing population needs more food supply not only in quantity but also in quality. To guarantee enough food supply from time to time, the government and relevant stakeholders need to prioritise boosting productivity in agriculture production and service. Sustaining agriculture worldwide is always important to strengthen the food value chain and industry. E-commerce is an enabler that drives the utilisation of information and communication technology adoption to boost business activities and create new opportunities in different application domains such as agriculture, education and health. Prioritising advancing agriculture is important to guarantee food security for the nation and the world population. There are key benefits of e-commerce to the agriculture domain including boosting the circulation of agriculture products and development in terms of communication and experience, a marketplace for promotion and price comparison, and customer relationship management of growing customers [4].

Universiti Putra Malaysia (UPM) is a leading university in agriculture in Malaysia. UPM is mandated by the Ministry of Higher Education (MOHE) to lead in food security. Agriculture is the mainstream field of study at UPM where the students are encouraged to relate the agriculture field with life, innovation and business. All students must take the agriculture subject as a requirement for Bachelor's degree graduation. Students at different academic levels are being exposed to the basics of

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agriculture and research and innovation with the advancement of technology in agriculture. Besides, UPM's contributions to R&D and commercialisation of technology and innovation are also significant. However, there is still room for improvement such as awareness among Malaysian youngsters to pay attention to the agriculture fields and business fields to encourage them to become entrepreneurs, technopreneurs, unipreneurs or start-up founders.

In this study, we focused on the benefits of e-commerce in boosting agriculture activities including a sustainable food value chain. This paper is structured as follows; Section 2 revealed issues related to food security as the focus domain area. Section 3 reviewed related works on the contribution of e-commerce as the solution to championing agriculture in sustaining food security and other alternatives. Section 4 introduced a model for a responsive agriculture hub via e-commerce to sustain food security. Section 5 explored a potential multi-sided e-commerce platform that can be developed based on the proposed framework. Section 6 discussed the validated results to prove the values of the proposed model. Lastly, Section 7 concluded that e-commerce is the best practice that boosts agriculture via a dynamic e-commerce hub.

II. Food Security Issues

According to the Oxford Dictionary, agriculture can be defined as the act of farming and the upbringing of certain types of animals with care and nutrition. The crops that are being planted and the animals that are raised are used mainly as food and to produce other products to fulfill human needs. Agriculture products can be sold to generate income. Comparing agriculture, forestry, and fishing, value added (% of GDP) in Malaysia, the value 8.9% in 2022 which is a bit lower than 95 in 2002 and lower than 14.6% in 1992. A similar decreasing pattern can be seen as well in almost all other countries in the world [5].

People have to survive especially during Movement Control Order (MCO), this has motivated the community to initiate agriculture activity and food production from home. In addition, the agriculture industry needed to save their agriculture and food production from being wasted due to the limitation of physical restrictions. Consequently, entrepreneurs starting to turn to e-commerce instead of selling products in physical shops. Aside from the effect of foreign trade, there is a rise in the home garden and urban farming projects in Malaysia during MCO as reported by the local newspaper The Star dated 30th September 2020. As people are being shut at home, this new trend of being slowly involved in urban agriculture is very helpful in optimising land use as it can cut the cost of living in cities, as well as malnutrition and food insecurity. There are also some community-based urban farming projects such as Sunway FutureX Farm, Kebun-Kebun Bangsar and Urban Hijau. However, some technologies can be used to further improve farms productivity yet it is not being highlighted and aware of. There is a need to integrate and assimilate efficient and latest agriculture technologies for farming projects.

Experienced farmers may have better and wider connections with industries thus easier for them to market and sell their agriculture supplies and products. However, small-scale and new farmers who have not yet gained much experience have to struggle with their limitations and challenges. Small-scale farmers must get support and collaboration from business partners among the experienced farmers as well as from the industries such as knowledge sharing, useful advice, funding support and technologies needed. Besides, lack of awareness and inactive involvement from the community as they did not realise that agriculture could improve many aspects of their life such as sufficient quality food supply and be their main source of income. The community is not interested in agriculture-related activities or projects because they find other activities such as binge-watching movies more fun than farming. Another factor that might contribute to the lack of community involvement is probably due to agriculture activities that are conducted on weekdays during working hours, when most people are occupied with their office work and students attending classes. There is a need to get the community involved because by participating they feel a sense of belonging and will motivate them to continue with the process of planning and implementing the project [6]. This can benefit both parties; the organisers as they understand what the community wants and the community can gain valuable knowledge related to agriculture technology for their farming projects.

In addition, youngsters find that farming is an old-fashioned job and only suitable for elderlies who have retired. In a study of 200 undergraduate students in southwest Nigeria, a total of 159 students admitted that they do not want to volunteer to participate in the agriculture field, which is 79.5% of total students. This is because they are not interested in it, they are lazy and they have a high perception that youngsters are eligible to venture into any other fields besides agriculture [7]. They also think that they might not be able to produce high income by selling fruits, vegetables, and livestock in the market. Of course, these are only youngsters' pre-assumptions as they are all not true. Even those who study agriculture have the possibility of working in the office as an admin or in the lab as a researcher. Agriculture is a very broad field, that people can explore more if they know how much it can benefit them and society.

Food security is very important for every country worldwide. There are issues related to food security in many countries nowadays. These food security issues for example limitations and problems including a shortage in the food supply, insufficient food available in the market and expensive food prices are real for customers. On the other hand, farmers are also facing difficulties such as not being supplied their fresh food, a broken food supply chain, food wastage and limited market access. In another word, a shortage of food supply can be the main reason for the expensive prices in the market. Besides, this mismatched food supply and demand other factors affected agriculture and food security such as expensive price, climate change and food wastage.

A. Expensive Price

Most people are unable to obtain healthy and sufficient food for themselves especially people from low income and B40 due to the price of food being expensive. According to the World Bank Group, almost all low-income and middle-income

countries have experienced high inflation; 88.2% of low-income countries, 91.1% of lower-middle-income countries, and 93% of upper-middle-income countries have experienced inflation levels above 5%, with many experiencing double-digit inflation [8]. The bank reported the proportion of high-income countries experiencing high inflation has increased dramatically, with approximately 82.1% experiencing high food price inflation. High food prices have triggered a global crisis, pushing millions further into extreme poverty and exacerbating hunger and malnutrition. More to that, the number of people experiencing acute food insecurity and in need of immediate assistance is expected to rise to 222 million across 53 countries and territories. Rising food commodity prices in 2021 were a major factor in pushing approximately 30 million additional people in low-income countries toward food insecurity.

B. Climate Change (Flood)

Climate change had a significant impact on agriculture. Farmers are feeling the effects of climate change, with rains arriving earlier. Freshwater is also becoming scarcer as sea levels rise and storm surges, cyclones, and other extreme weather events become more frequent and intense. Climate change impacts include flood disasters, which affect food production and, as a result, food insecurity. While climate change may have a positive impact in some areas, it may have a negative impact in others due to excess or scarcity of water, which hurts food production [9]. Flood disasters have reportedly become more common, with disastrous consequences for food production. Moreover, the crop is suffering as a result of the constant rain and flooding in Malaysia. Even if there are no floods, too much rain kills crops. This causes both hardy and leafy vegetables to be limited to obtain. RM111.95 million in flood losses were recorded in the agriculture, and agrofood sectors [10]. According to the Agriculture and Food Security Minister, Mohamad Sabu Said, damages and losses over 24,700 hectares of agricultural land are recorded by the Ministry Disaster Management Center report. The effect of climate change is not only affecting the farmers but also affecting the consumers to obtain sufficient food as flood causes the shortage of food supply.

C. Food Wastage

Food waste occurs when edible food is discarded by consumers after it spoils or has passed its expiration date. Global food waste is a threat to food security, and it should be a serious concern for any country that cares about its citizens. This is because, while tonnes of edible food waste are lost or wasted during harvesting and production, throwing away edible food waste is a common practice in most affluent households in urban cities. Despite this pitiful waste situation, thousands of households continue to struggle to have daily square meals in most urban and rural areas (food insecurity) [11]. In the year 2021, it has been recorded that Malaysians waste 4,081 tonnes of edible food every day [12]. It is enough to fill one and a half Olympic-sized swimming pools or feed three million people three times a day. The majority of food waste ends up in landfills. As waste decomposes, it emits greenhouse gases such as carbon dioxide and methane, which contribute to climate change and cause temperatures to rise. At landfill sites, degraded food waste may also produce leachate, contaminating underground water and aquatic ecosystems. Consequently, it will affect the difficulties of people consuming enough food in the future and at the same time it endangers human health.

Agriculture e-commerce can open up agriculture supply and expand the business value chain to more efficient connections and supports. In addition, it creates fairer incomes for the stakeholders in the partnership and networking agriculture supply. Benefits of agriculture e-commerce in economic to stakeholders including farmers, communities and the wider society in the form of improved income and livelihood. In terms of the social impact parallel with the UN Sustainability Goals (SDGs) such as reducing wastage, improving incomes, financial inclusion, increasing productivity and impact on adjacent services [13]. The impact of rural e-commerce in China has a positive impact on the rural economy, agrifood supply chain, lifestyles, entrepreneurship and ultimately transforming the rural sector in the 21st century which covers the economic, social and environmental benefits [14].

III. Related Work

E-commerce offers dynamic attraction via a hybrid value chain as the solution to boost supply and fulfill demand [15]. There are eight elements of the key successful factors as shown in Fig. 1. E-commerce drives online applications as solutions from provider to consumer for various implementation domains including agriculture, education, health, etc. A successful e-commerce platform disrupts the industry by proactively matching supply and demand. Advanced concepts of supply-driven and demand-oriented are important for pioneering e-commerce and leading online businesses. Comprehensive market understanding with a systematic business model and strategy is critical. Therefore, it is a must-have impactful innovation as a useful solution, a niche market as the right target, disrupt the industry with the best strategy, product-market fit to remain competitive, and a sustainable business model to organically grow.

The framework of e-commerce dynamic attraction via a hybrid value chain to boost supply and fulfill demand can be used as a reference and guidance to many different stakeholders as key players in the agriculture hub. The great potential of the framework to benefit them for example shortening the food industry value chain, rapidly matching supply and demand, and digitalisation to save resources. There are gaps between the utilisation of IT and common traditional best practices. Modernising agriculture with great impact via an e-commerce platform can be realised by validating all the stated elements including the useful solution as the impactful innovation, the right target of a niche market, the best strategy to disrupt the industry, competitively offering of product-market fit, and organically grow with the development of the sustainable business model.

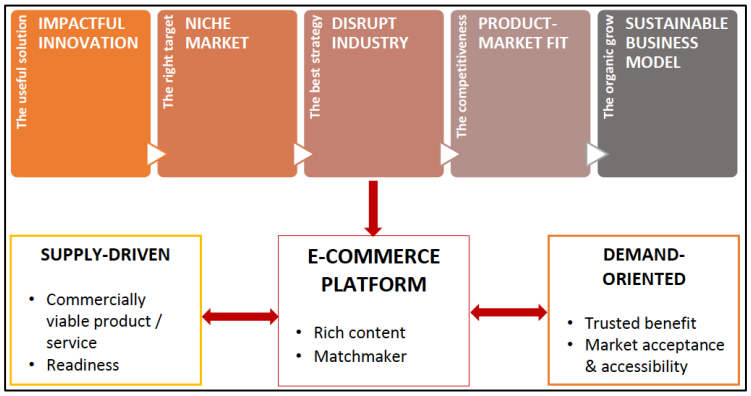

Fig. 1. A framework of e-commerce dynamic attraction via hybrid value chain to boost supply and fulfil demand

There are initiatives in Malaysia to bring fresh food from farms to the marketplace such as the following:

OurFarm is an e-commerce platform and warehouse by AirAsia [16]. Plus, this platform provides wholesale purchases of fresh agriculture products and customers can get lower prices buying in bulk. This platform is supported by the Ministry of Agriculture and Food Security (MAFS), formerly known as the Ministry of Agriculture and Food Industries (MOA). Thus, making this website more trustable for customers to do online transactions. The website already puts the minimum number of agriculture products that clients can order and they can increase it according to their needs. For fish and meat products, they have both options, which are fresh and frozen. Since it offers on-time delivery, customers do not have to worry if the fresh products will be rotten as the process is very fast since they use aircraft freight to transport the product.

AgroBazaar (https://www.agrobazaar.com.my/) is supported by MAFS and many big agencies such as the Federal Agricultural Marketing Authority (FAMA), Malaysian Agricultural Research and Development Institute (MARDI), Kemubu Agricultural Development Authority (KADA) and Muda Agricultural Development Authority (MADA) [17]. Interestingly AgroBazaar has collaborated with many delivery services such as Ninjavan, J&T Express, POS Laju, teleport, Grab Express, asiaXpress, LalaMove and DHL. Customers can choose according to their preference and the availability of the courier to send the products to their area. It also states the amount of discount, which can attract customer's attention and will create a sense of urgency for them to buy as soon as possible as they do not want to miss the discount opportunity.

Mega Farmers' Market was established to provide the farmers' market with a fresh image and to keep it competitive [18]. It is a successful effort for agricultural businesses and manufacturer[1]s, as well as farmers and fishers, who engage in the agricultural market. The Mega Agricultural Market has incorporated various new features, including a more entertaining and customer-friendly ambiance, improved product display, and a cleaner and larger shopping area. FAMA has also established the Fresh Fruits Stalls (GBBS) program, which is supervised by the organisation. It's essentially a network of local entrepreneurs' fruit stands that have been chosen for upgrading purposes with a uniform, clean, and appealing product arrangement. GBBS has evolved into a new way for consumers to obtain high-quality fruits as well as a way for entrepreneurs to expand their fruit business. It is an attempt to entice the public to obtain direct supplies and increase per capita consumption of local fruits. FAMA has so far established 163 businesses with 326 stalls across the country.

Dropee (https://www.dropee.com/) where they sell fresh and frozen vegetables but not poultry and fishery [19]. Plus, they also sell other types of products such as bread, snacks, office furniture, and electronic stuff. There is no minimum order rule on this website. The website user interface (UI) is very simple therefore, it is easy to navigate between pages and browse through the page without being distracted.

MDEC (eLadang) (https://mdec.my/digitalagtech) is a pilot initiative driven by MDEC, in collaboration with ecosystem partners [20]. They empower the agriculture sector by infusing 4IR technologies (Internet of Things (IoT), Big Data Analytics (BDA) and even Artificial Intelligence (AI)) to catalyze digital adoption towards improving the livelihood of the many farmers across the nation. The eLADANG provides the training, and equipment for the people involved in the agriculture sector with their crops and yield. They also provide training for the farmers to keep maintain their farms.

CityFarm Malaysia (https://cityfarm.my/) was founded to inspire more city farmers with the ability to grow locally from anywhere for a more sustainable future of food production [21]. It launched in 2016 with an indoor controlled environment vertical show farm (450sqf) that is capable of producing 2000 heads of lettuce every month. CityFarm Malaysia wishes to play a part in the movement by creating a simple and affordable farming system in cities, the ability to satisfy the rapid growth in consumer demand for affordable, high-quality, locally produced crops in any climate, and provide training services to the youngsters on the importance of farming and how you can play a part to make the world a better place by growing food that is healthy, clean and fresh. They also provide a platform where people can buy all the necessary equipment to start their urban farming journey.

[a.] [1] http://hbrppublication.com/OJS/index.php/RAWDD/article/view/2863 (*Wan Nurhayati et. al., 2023*)

To be able to assimilate people functioning in the same pillar of agriculture in Malaysia, there is a need to take actions by inventing a platform so that all the people who are involved in the agriculture sector can play a role in enhancing the agricultural sector. This is important as agriculture has been the backbone of the Malaysian economy ever since. People's interest in joining the agriculture sector is also needed in the long run so there will be future generations that will inherit the agriculture practices. If there is less or none of them that are interested in this precious field, there will be problems in advancing in this sector. The term of studying in the agriculture field brings many unwanted ideas as the benefits of these areas of study are not widely promoted. Hence, it is important to instill in the young the knowledge to come out with talents in agriculture and this is where UPM, as it strives to be the center of excellence in agriculture, should play an important role in setting a platform where it is conventional for the people to look for agriculture-related information.

IV. Model for Responsive Agriculture Hub Via E-Commerce to Sustain Food Security

Responsiveness is the key to improve the efficiency and effectiveness of agriculture and the food security value chain. Developing a model for a responsive agriculture hub via e-commerce transforms the traditional sequential agriculture value chain into a dynamic, efficient, and resilient system. By leveraging technology, data-driven decision-making, and inclusive market access, this transformation enhances food security, sustainability, and economic opportunities for stakeholders across the agricultural ecosystem. Justifications for the key benefits from the model as in the following:

1) Efficiency improvement: Traditional agriculture value chains often involve numerous intermediaries and sequential processes, leading to inefficiencies in production, distribution, and access to markets. By developing a model for a responsive agriculture hub via e-commerce, we can streamline these processes, reducing the number of intermediaries and enabling direct interactions between farmers and consumers. This streamlining enhances overall efficiency, resulting in cost savings, reduced food waste, and improved resource utilization.

2) Real-time decision making: The adoption of e-commerce platforms in agriculture facilitates the collection and analysis of real-time data throughout the value chain. By leveraging data analytics and predictive algorithms, stakeholders can make informed decisions promptly. This capability is crucial in responding rapidly to market fluctuations, weather patterns, and other dynamic factors affecting agricultural production and distribution, thereby ensuring the timely availability of food supplies.

3) Supply chain resilience: Agriculture value chains are susceptible to disruptions caused by various factors such as natural disasters, supply chain bottlenecks, and socio-economic crises. Transforming the sequential agriculture value chain into a responsive agriculture hub enhances supply chain resilience. By diversifying distribution channels, optimizing inventory management, and implementing contingency plans enabled by e-commerce platforms, stakeholders can mitigate the impact of disruptions and maintain consistent food supplies, thus contributing to food security.

4) Market access and inclusivity: E-commerce platforms provide farmers with broader market access beyond traditional physical markets, enabling them to reach a larger customer base locally, nationally, and even globally. By eliminating geographical barriers and intermediaries, smallholder farmers and rural communities can access markets directly, empowering them economically and promoting inclusivity in the agriculture sector. This inclusivity strengthens the overall resilience of the food system by diversifying sources of supply and demand.

5) Sustainability enhancement: A responsive agriculture hub via e-commerce facilitates the adoption of sustainable agricultural practices by providing incentives and market opportunities for environmentally friendly production methods. By promoting transparency and traceability in the supply chain, consumers can make informed choices that support sustainable farming practices. Additionally, the optimization of logistics and transportation enabled by e-commerce reduces carbon emissions and environmental impact, contributing to the overall sustainability of the agriculture sector.

We propose a model for a responsive agriculture hub via e-commerce to sustain food security as shown in Fig. 2. Transforming the sequential agriculture value chain into a responsive agriculture hub is necessary. The hub consists of important elements and is accessible to different targeted stakeholders at anytime and anywhere. These elements include knowledge, farm, product, logistic service, shop, customer persona and food security. Whereas, the stakeholders include experts, farmers (suppliers), manufacturers, distributors, marketers, customers and the community. The importance of this model is to connect and leverage the following engagements:

- Source of data, information and knowledge concerning the agriculture experts from such as researchers and consultants the university, research institute, industry, association, government and experienced individual farmers.
- Agriculture hub with responsive connectivity from various stakeholders in the agriculture and food production value chain such as supplier farm, food manufacturer, delivery service, marketer and customer.
- Digital matching platform via e-commerce to create knowledge and business networking to speed up all the necessary processes and increase agriculture and food productivity.

The proposed model (Fig. 2) for a responsive agriculture hub via e-commerce to sustain food security consists of these components with stakeholders and roles as in Table I:

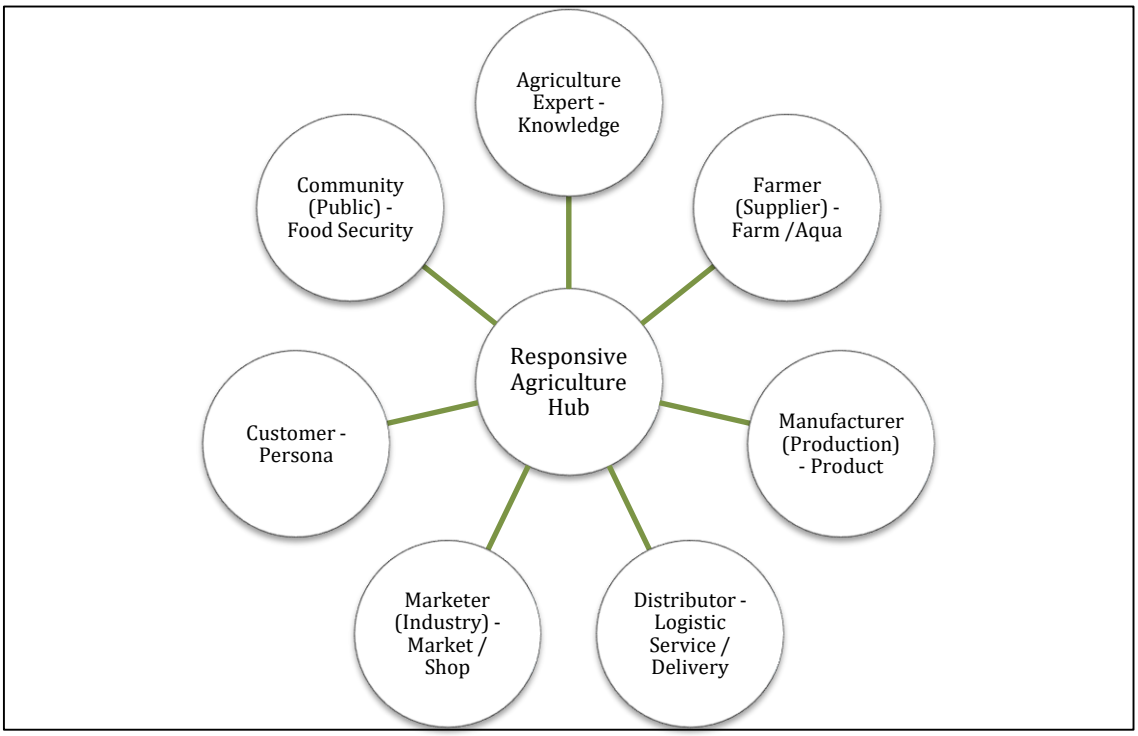

Fig. 2. Model for responsive agriculture hub via e-commerce to sustain food security

TABLE I. ELEMENTS OF RESPONSIVE AGRICULTURE HUB CONSISTS OF COMPONENTS, STAKEHOLDERS AND ROLE

COMPONENT	STAKEHOLDER	ROLE
Agriculture Expert – Knowledge	Agriculture expert is an experienced individual farmer; researcher and consultant from • farm • the university • research institute • industry • association • government	Source of data, information and knowledge with reference
Farmer (Supplier) – Farm/Aqua	Farmer is a direct supplier from farm and/or aqua pond	Agriculture hub with responsive connectivity to provide from farm-to-market fresh food such as fruits and vegetables
Manufacturer (Production) – Product	Manufacturer is the agriculture product and food production line	Process, produce and pack food from the farm (supplier)
Distributor – Logistic Service/Delivery	Distributor is the delivery service to bring agriculture and food products from farm-to-table	Logistic service to shorten the food value chain
Marketer (Industry) – Market/Shop	Marketer is mainly industry to reach out the targeted market	Do promotion and marketing the agriculture and food products to the targeted market
Customer – Persona	Customer is the one who spending money for the value and benefit they got from the agriculture and food products	Buy the agriculture and food products
Community (Public) – Food Security	Community is the crowd/people who in need of the agriculture and food products	Engage in the agriculture circle or e-commerce platform to seek for information, buy product, etc.

V. POTENTIAL MULTI-SIDED E-COMMERCE PLATFORM AS A CASE STUDY

Referring to the proposed model as a guideline, an e-commerce multi-sided platform can be developed as a responsive agriculture hub. Here are examples of e-commerce projects being proposed by e-commerce students at the Bachelor's degree level for the e-commerce course as a case study; ASFALIS mock-up.

ASFALIS is an e-commerce platform to overcome the issue of food insecurity for both consumers and farmers as shown in Fig. 3. The platform is called ASFALIS because the word ASFALIS comes from the word in Greek that gives a meaning of 'secure'. This is to explain that this platform is to make the earth sustainable by securing the food supply and providing healthy food to all people at anytime to make the world a better place. ASFALIS is a consumer-friendly platform that offers a variety of features for customers to purchase foods and for farmers or providers to supply fresh foods. It acts as a matching

platform to connect both consumers and farmers. To be specific, the targeted customers that are going to use this platform are firstly, households that come from low-income backgrounds. This is to make sure that these households can consume enough nutritious foods to prevent poverty issues from happening. Besides, another targeted customer is the active farmers. This platform can help the farmers to market themselves by selling the food products that have harvested. Also, it is an opportunity for farmers to expand their businesses by developing new market venues and at the same time it would help them to gain profit.

Fig. 3. ASFALIS main page

ASFALIS provides originality and novelty for the food security e-commerce solution. This is because ASFALIS offers features that may not be able to get from other e-commerce platforms such as updating Malaysia's population statistics every day, giving notification when there is serious climate change might occur, consumer can sell their expiry date foods to other consumers, farmers can locate nearby agricultural land, consumers can search the nearby farmers' market and ASFALIS also suggesting amount of foods to eat per day in calories to the consumer according to their Body Mass Index (BMI). Furthermore, ASFALIS is the first food security e-commerce platform named ASFALIS as there is no other website or platform that has the name ASFALIS. This can be proven that ASFALIS is an original platform that exists to serve the very best of all parties including the consumers, customers and farmers. All the solutions and features that have been stated above also could not be found and are not available in other e-commerce platforms such as Econsave, Lotus and Giant. This can be explained that ASFALIS is the only platform that offers a variety of modules and functions that can be optimized by consumers and farmers without facing any difficulties and obstacles.

ASFALIS acts as a matching platform between consumers and farmers to solve food security issues. To give and serve the best for both consumer and farmer, ASFALIS provides a number of unique value proposition (UVP) that only available in ASFALIS and might not exist in another platform. Firstly, ASFALIS can be utilised by both consumers and farmers. This can be emphasised that ASFALIS provides fresh, natural, organic and brand-new foods and raw materials for the consumer as it is being sold directly after the products are harvested by the farmers as shown in Fig. 4.

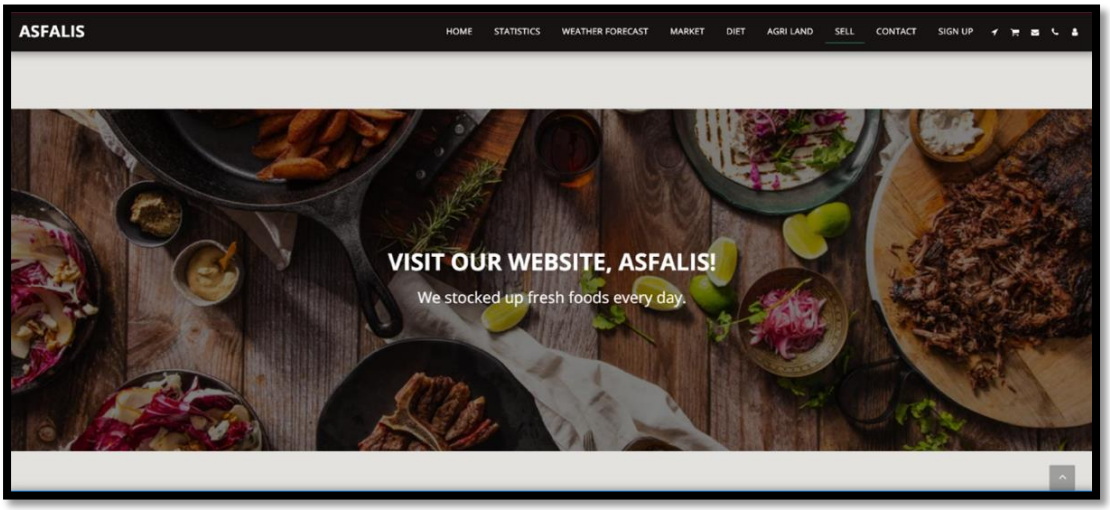

Fig. 4. Page for farmers to stock up their production

Secondly, the module in ASFALIS could help the farmers in various ways. In ASFALIS platform is equipped with features that constantly remind and notify the farmers regarding serious weather or climate situations that might happen, able to search for available agricultural land and also portray up-to-date Malaysia population statistics every day as shown in Fig. 5. Through this module and function, it could help the farmers to plan their farming activities, then farmers can identify the agricultural land that they can buy and own to enhance and increase their farming activities. Also, from the statistics of Malaysia's population in the ASFALIS platform, the farmers can prepare the food supply that aligns with the population.

Offering cheap prices of food could help consumers of low income to obtain sufficient and healthy in their daily lives. Besides, ASFALIS is a multi-platform that allows consumers to sell their soon-expiry date food through this platform. This means that the ASFALIS platform helps the world from food wastage and at the same time the consumers can make a profit through this platform.

ASFALIS e-commerce platform can be categorised into three modules which are consumers, platform developers and farmers.

A. Module 1: Consumers

Firstly, modules for consumers. To enable the consumer to use the platform, the consumer needs to sign up for an account on the website. Then, there is a module for consumers to be able to see and browse the available list of food items that they want to purchase as shown in Fig. 6. The raw materials available in ASFALIS include vegetables, fruits, poultries, fish and seafood. ASFALIS offers an affordable price for consumers who can afford to buy for all groups all people including people from B40. With the price that is being offered by ASFALIS, it would help to reduce food insecurity as all people got to buy and consume sufficient nutrients of food.

Moreover, there is a shopping cart for the consumer to place their order. In the shopping cart, the consumer can check out the items that they intend to buy. Consumers can use the shopping cart to select and hold the products they want to buy. It keeps track of the consumers' session, allowing them to leave the site and return later with items still in their shopping cart. The cart collects the consumer's payment information during the checkout process. This data is forwarded to the third-party payment processor. The order details are sent to other modules, such as the order management system (OMS), inventory management system, and customer relationship management (CRM) system. This module would ease consumers' activity to make any purchase in ASFALIS.

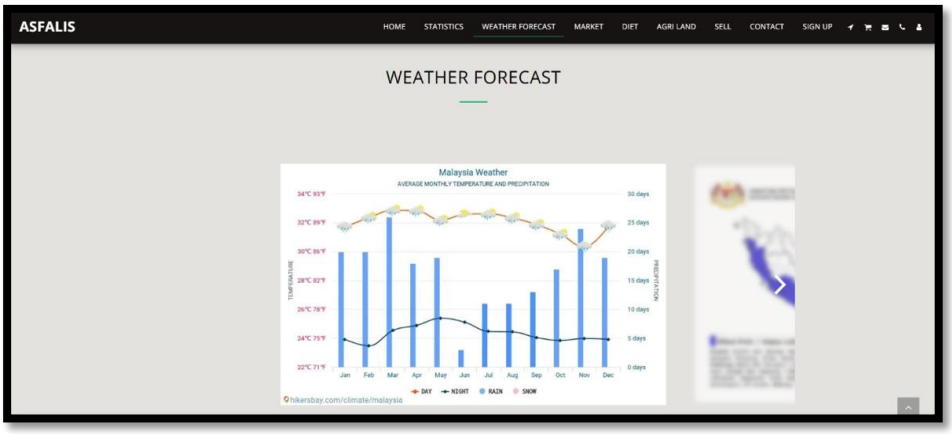

Fig. 5. Weather forecast page

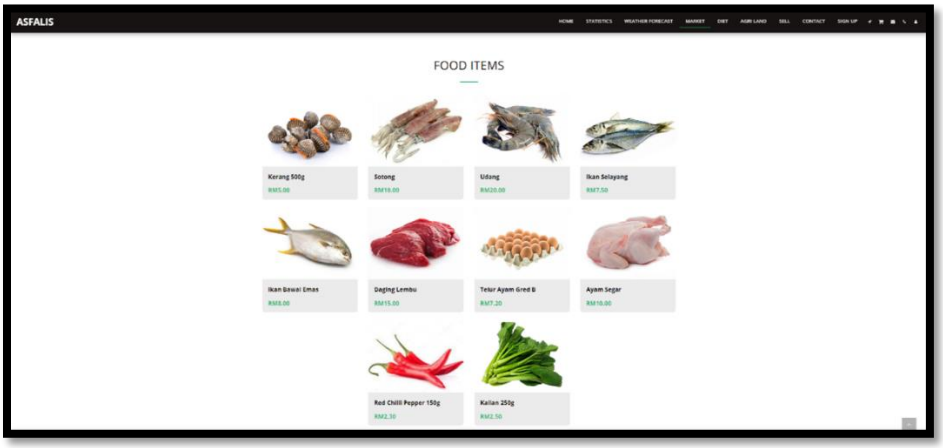

Fig. 6. E-catalogue page

In addition, all the food provided by ASFALIS are all fresh and brand new. The foods are being stocked up regularly. We also practiced hygiene in ASFALIS. Cleanliness is the main priority to serving the very best consumers. The process of handling, preparing, and storing food or drink in a manner that minimises the risk of consumers becoming ill from food-borne disease. It is to aim to keep food from becoming contaminated and causing food poisoning. On this ASFALIS website, the consumer. Besides, we also provide a search function for the consumer to look up nearby farmers' market locations. This enables consumers to choose and make a purchase with their preferred farmers market store.

Moreover, to avoid the problem of food wastage among people in Malaysia, ASFALIS has a module and function that suggests the consumer to how many amounts of food calories to consume per day. This function is being addressed through the body mass index (BMI) of people who have entered their information regarding BMI during the process of account registration. Through this module and function, the consumer can plan their daily life of meals to consume in advance so that it will allow them consumer to see how much they are eating and at the same time it can make maximum room for healthy choices and nutritionally well-balanced meals as shown in Fig. 7. This way, it can ensure all the consumer's meals include the requisite proteins, carbs and grains.

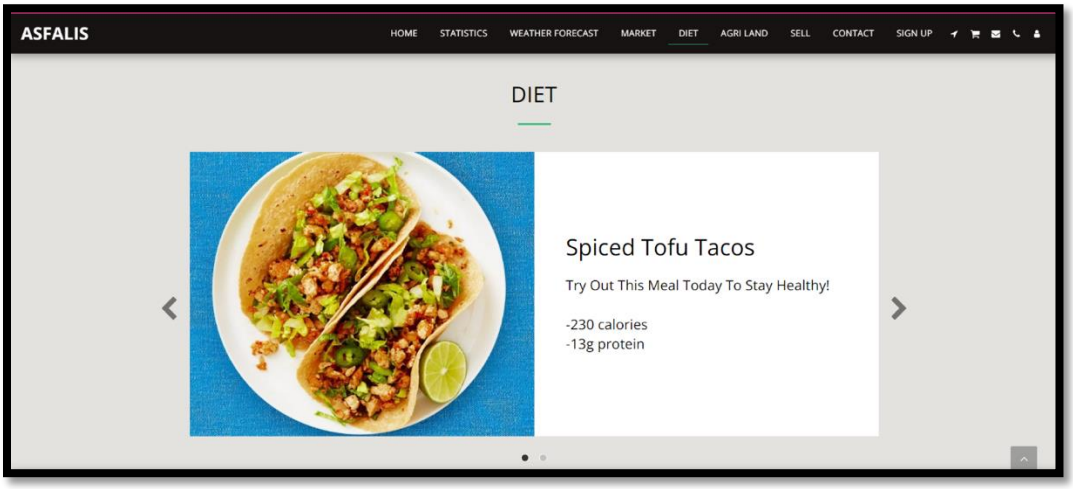

Fig. 7. Diet meal plan page

Besides, other than buying food, the consumer can also do the activity selling in terms of selling soon-expired food at a cheaper and discount price to other consumers. This means the food products being sold are extraordinarily cheap which is half of their market price. This enables the consumer to purchase the food hassle-free. They get to enjoy the food before the expiry date at the cheapest price. Thus, the consumer not only obtains profit from selling expiring date food but also the issue of food wastage in Malaysia could be reduced.

B. Module 2: Platform Owner

The second module is the platform owner. Platform owner can see the activities that have been done by both consumers and farmers. The amount of profit is automatically divided between the platform owner and farmers. For the profit, it has been calculated that the commission rate for the platform owner is 20% of the profit and 80% is for the farmers. The consumer who sells their soon expired date food will solely get all the profits and commission rate.

Besides, there is a chat in ASFALIS that allows consumers and farmers to communicate directly with the platform owner. This is important for them to address the issues that may involve such as technical issues. Therefore, the platform owner can take immediate action towards the issues. Furthermore, any new farmers who would like to market in ASFALIS can just enter the website and register themselves. The registration of new farmers will be notified to the platform owner so that the platform owner can keep track of all the activities happening on the website and also the cash flow of the profits.

C. Module 3: Farmers

The third module in ASFALIS is the farmers. The farmers are not restricted to only one type of farmer but also it includes all types of farmers which are agriculture farmers and aquaculture farmers. To be able to optimize the platform, the farmers have to register themselves on the website as farmers. Then, they get to market the products they harvested. The items that will be checked out by consumers will then get notified to the farmers. Hence, farmers can get the item prepared and delivered to the consumer.

Additionally, farmers also get a notification when there is expected serious climate change such as floods or droughts that might occur. From this climate notification that has been received by the farmers, the farmers get to plan the amount of food to be planted and also when is the time they need to stop their farming activities for a while and wait until the weather is suitable for farming. Through this module and function, it can avoid tonnes of food loss and will guarantee food security in Malaysia. ASFALIS also suggested to the farmers the preferred amounts of fruits or vegetables that they can be planted during unstable weather conditions.

On top of that, on the home page of the website, there will be current statistics on Malaysia's population. The statistics will be generated or updated automatically according to the real

Malaysian population every day. This can help the farmers to predict the amounts of products to produce based on the population. It is to align the population and the food supply by farmers so that no one will be left behind from getting insufficient food and at the same time no food wastage will happen.

Furthermore, the delivery of food is available 24/7 so the consumer can make any purchase at anytime and anywhere. The consumer does not need to worry regarding the delivery of their food items as ASFALIS only offers fast delivery service as shown in Fig. 8. Also, the farmers will gain their income directly as the profit will be auto-generated to their bank account as soon as the consumer makes a purchase. ASFALIS accepts both cash and online payment for consumers to make a purchase. Consumers are more likely to pay faster and sooner if they have multiple payment options. Providing multiple payment options for consumers benefits ASFALIS as well.

The farmers also get to market themselves through the ASFALIS platform and can expose themselves widely in Malaysia as shown in Fig. 9. This is one of the ways for the farmers to increase their brand exposure so that many people get to know their brand and buy from them. Also, in ASFALIS we have a module function for the farmers to search for available agricultural land in Malaysia for them to do farming activities. It would help them to locate nearby areas that are still accessible for them to buy and own the land. Therefore, the farmers would not find it difficult to survey around physically looking for available agricultural land. The farmers can simply use ASFALIS as a solution to look for agricultural land as shown in Fig. 10.

ASFALIS platform involves two types of business models which are Business-to-Consumers (B2C) and Consumer-to-Consumer (C2C). Firstly, ASFALIS utilises a B2C business model for e-commerce. This process occurs between farmers and consumers. This means that the farmers market their products and foods directly to the end consumers or customers. B2C is a business that sells directly to consumers as shown in Fig. 11. Anything users buy as a consumer in an online store, from foods and raw material supplies, is a B2C transaction. ASFALIS is a B2C because it involves a purchase that has a much shorter decision-making process than a Business to Business (B2B) purchase, particularly for lower-value items. Because of the shorter sales cycle, ASFALIS is a B2C that typically spends less money on marketing to make a sale while having a lower average order value and fewer recurring orders than the B2B counterparts. To market directly to our customers and make their lives easier, ASFALIS has used technology such as mobile apps, native advertising, and remarketing.

Next, ASFALIS also utilises C2C as a business model in e-commerce solutions. The C2C business model can be seen between a consumer and another consumer when the consumer wants to sell their soon-expiry date food products to other consumers by using this platform as shown in Fig. 12. Consumers sell goods directly to other consumers in C2C e-commerce. ASFALIS enables the consumer to sell their soon-expiry date foods at their prices without the need for their online storefront. They typically make money by charging transaction or listing fees and connect consumers to exchange goods. C2C businesses benefit from self-propelled growth by motivated buyers and sellers, but quality control and technology maintenance are major challenges. Consumers benefit from product competition and frequently find items that are difficult to find elsewhere. Furthermore, because there are no retailers or wholesalers, sellers' margins can be higher than with traditional pricing methods. C2C sites are convenient because they eliminate the need to visit a physical store. Buyers come to sellers after they list their products online.

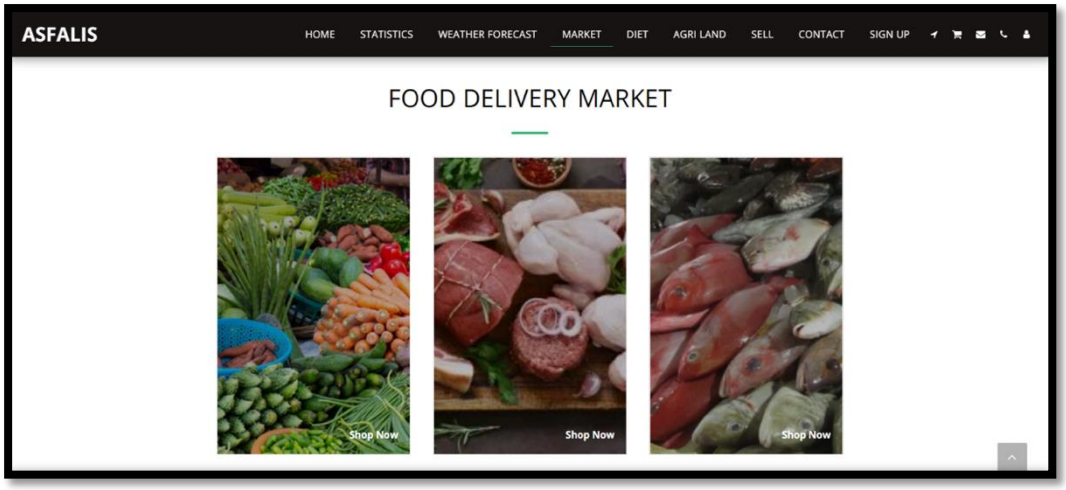

Fig. 8. Food delivery page

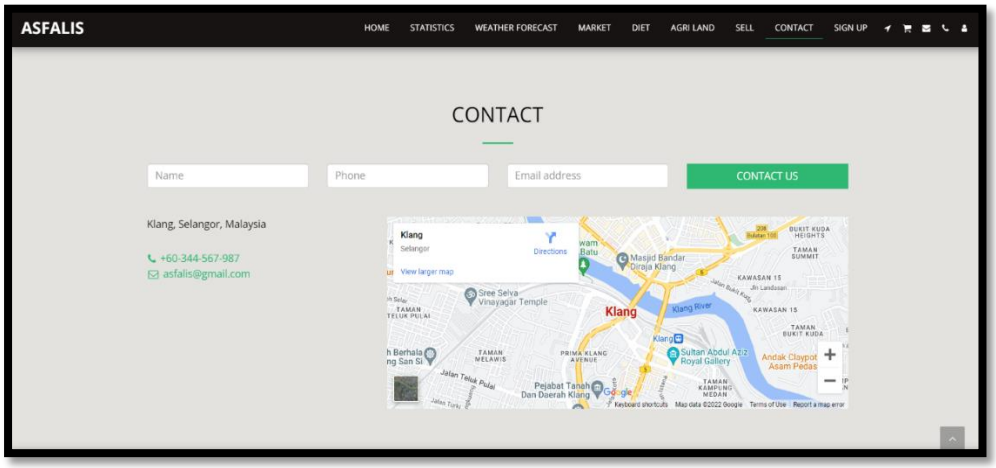

Fig. 9. Contact detail page

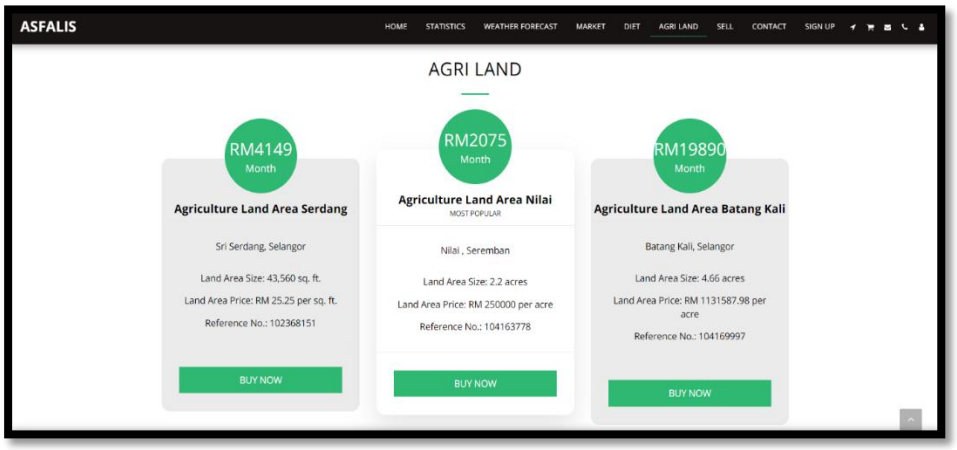

Fig. 10. Agriculture land information page

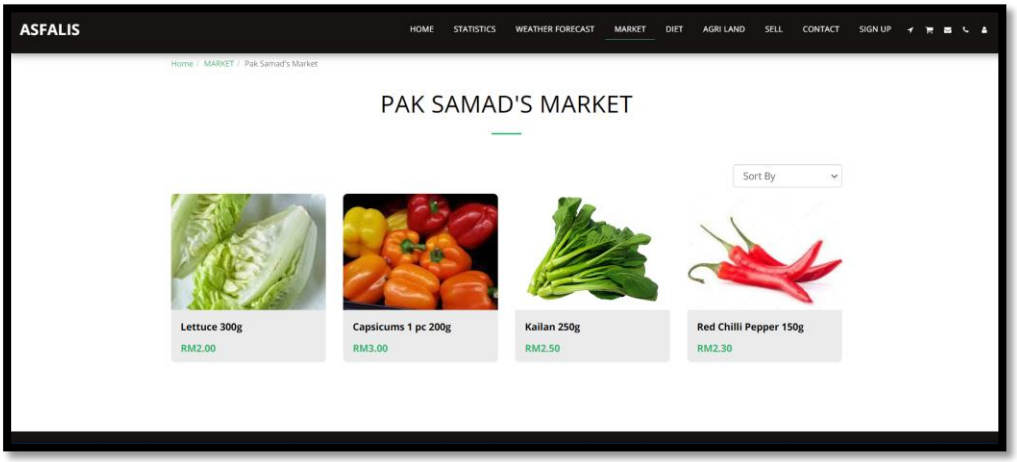

Fig. 11. B2C from a market

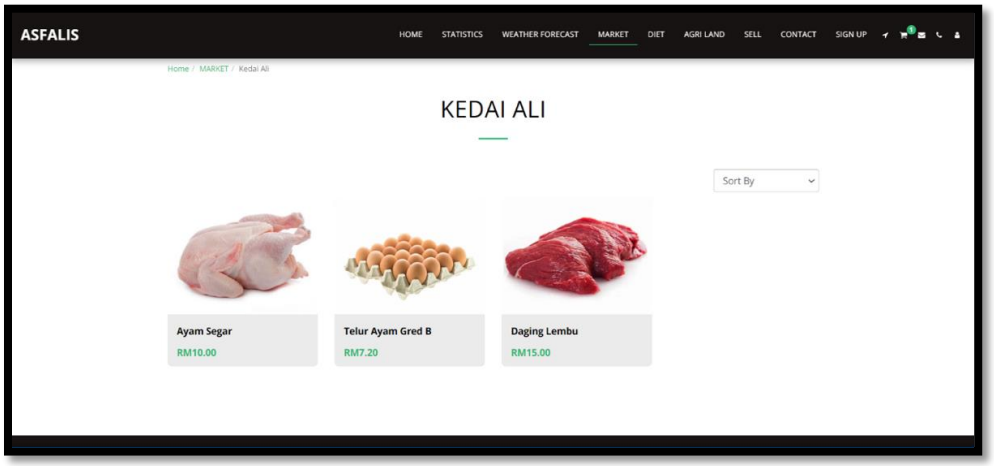

Fig. 12. C2C from a shop

VI. Results and Discussion

The case study as the outcome results presented herein confirms the efficacy of the proposed model for a responsive agriculture hub via e-commerce in transforming the traditional sequential agriculture value chain into a dynamic, efficient, and resilient system. Through a comprehensive evaluation of key performance indicators and qualitative assessments, the benefits of this transformative approach have been substantiated across various dimensions of agricultural production, distribution, and market access.

1) Enhanced Efficiency and Cost Savings:

a) The implementation of the responsive agriculture hub model led to notable improvements in efficiency throughout the value chain. By streamlining processes and reducing reliance on intermediaries, the time taken for product sourcing, packaging, and delivery was significantly reduced.

b) Cost savings were observed across multiple stages of the value chain, attributable to reduced transportation costs, minimised wastage through optimised inventory management, and lower transactional expenses associated with direct farmer-to-consumer interactions facilitated by e-commerce platforms.

2) Improved Resilience to Disruptions:

a) The dynamic nature of the responsive agriculture hub enabled stakeholders to respond swiftly to unforeseen disruptions, such as supply chain bottlenecks, adverse weather events, and market fluctuations.

b) Through real-time data analytics and predictive algorithms, the model facilitated proactive decision-making, allowing for timely adjustments in production schedules, inventory levels, and distribution routes to mitigate the impact of disruptions and ensure uninterrupted food supplies.

3) Expanded Market Access and Inclusivity:

a) The adoption of e-commerce platforms broadened market access for farmers, particularly smallholders and rural communities, who traditionally faced challenges in reaching distant or urban markets.

b) Direct-to-consumer sales facilitated by the responsive agriculture hub empowered farmers to capture a larger share of the value chain, thereby enhancing their economic viability and promoting inclusivity within the agriculture sector.

4) Promotion of Sustainable Practices:

a) The model incentivised the adoption of sustainable agricultural practices by providing market premiums for eco-friendly products and promoting transparency in sourcing and production methods.

b) Consumers exhibited a growing preference for sustainably sourced agricultural products, leading to increased demand for certified organic, fair trade, and locally grown produce, thus driving positive environmental and social outcomes.

In summary, the validated results underscore the transformative potential of the proposed model for a responsive agriculture hub via e-commerce in revolutionizing the traditional sequential agriculture value chain. By harnessing technology, data-driven decision-making, and inclusive market access, this innovative approach enhances efficiency, resilience, sustainability, and stakeholder satisfaction, thereby contributing to the overarching goal of achieving food security in an increasingly complex and interconnected world.

VII. Conclusion

Agriculture and food production can be benefited from the advancement of IT such as e-commerce platforms. Traditional businesses particularly the food industry value chain can be shortened to make it more effective reflecting the cost and time savings. Limitations to bringing from the farm to market especially during and after COVID-19 disease hit the world must be stopped and improved. There is an urgent call for local farmers and business owners to shift to e-commerce platforms to sell their agriculture and food products. They need to be digitally savvy to keep up with current technologies. It is important to increase the visibility of the agriculture sector including in Malaysia to make this sector grow until those small farmers and business owners become internationally known.

The proposed model for a responsive agriculture hub via e-commerce to sustain food security is important to guide agriculture and food industry stakeholders. Leading competitively towards creating new value to solve food insecurity issues such as expensive prices, climate change and food wastage needs a new shift of paradigm. The model has comprehensively highlighted critical components, actors and roles. Transforming agriculture as the responsive hub to the agriculture and food industry stakeholders needs support and actions from various strengths. These included agriculture experts with knowledge, farmers as direct suppliers from their farm/aqua, manufacturers for quality production, distributors who provide logistics and delivery services, marketers as the role of the industry to reach out to real markets on a mass scale, customers as the targeted niche market by understanding their persona, and community as the public crowd to make successful of food security in a complete cycle.

This study is important to be extended through many other contributions. For example, the development of an early prototype, ASFALIS to prove that the model can translated into real implementation as a case study. There are other potentials for e-commerce applications in the agriculture domain that can be developed based on the proposed model with the objectives to realise a responsive agriculture hub to benefit stakeholders and uplift agriculture and food industries at different levels in the future.

The way forward is to gain stakeholder satisfaction and trust in the responsive agriculture hub model. These include farmers to appreciating the fair pricing, transparent transactions, and timely payments facilitated by e-commerce platforms; and consumers expressing confidence in the quality, freshness, and traceability of products sourced through the hub, fostering long-term relationships and loyalty to participating farmers and brands. More future works can be explored from the proposed model such as enriching content and collaborations through responsive agriculture hubs via e-commerce platforms.

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