The Pull and Push Factors Towards the Adoption of Agricultural Revolution 4.0 (AR4.0) for Agro-Food Supply Chain (AFSC) in SMIs Agro-based in Malaysia

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Abstract

Nowadays, the agro-food industry is facing complicated challenges, because markets are moving fast, competition is growing and the products and production is also complex. However, there are many issues and obstacles arise mainly in the supply chain of this industry. The transformation in organization is very essential for the practitioners to keep them compete and sustain in the business field. One of the measures to allow small and medium-sized industries (SMIs) to respond to the uncertainties is by the agricultural modernization through the adoption of technology and innovation. Therefore, the study specifically aims to review the factors affecting adoption of agricultural revolution 4.0 (AR4.0) technology and was undertaken as a conceptual framework for AR4.0 adoption from the view point of pull and push factor supported by extensive literature review. The assessment of pull and push factor is dependent on the strategy, technology readiness, organisation support, people, environment, food security, food integrity, food safety, food waste and food availability. The findings of this study are useful to SMIs owners and also to the government to bridge an initiative to the adoption of Agricultural Revolution 4.0 (AR4.0) and the understanding of emerging concepts in AR4.0. This study is expected to add to current knowledge and spark thoughts among intellectuals, thereby paving the path for future experimental research.

Keywords
Pull Factor, Push Factor, Agricultural Revolution 4.0 (AR4.0), Malaysia, SMIs

1. Introduction
It is acknowledged that population in Malaysia is expected to grow by 45 percent by 2050, from 30.7 million to 44.4 million people, putting additional strain on the existing food system to meet demand (UN DESA 2018). As a consequence, Malaysia's industry of food has been upgrading and developing not only to fulfil local demand, but also to meet global demand for standards of food and quality, as well as stringent requirements from end users, international customers, and governments in various countries. Despite contributing only 8.2% of GDP, agriculture plays an important role in the development agenda of national socio-economic, especially in reducing poverty, ensuring economic equity, ensuring safety of food and food security, and ensuring sustainability, as outlined in the Sustainable Development Goals (SDGs) (FAO 2018). With an ever-increasing population, ensuring quality food and access to it becomes a major economic obstacle. With the passing of time and an unmatched rate of population growth, food security becomes the core and immediate focus of economies (IINS, 10th April, 2020).

Surprisingly, food security is a result of long-term food systems. According to the World Bank (2015), AFSC would have to provide food and nutrition security while facing unprecedented global environmental, social, and economic challenges such as resource scarcity, ecosystem degradation, and climate change challenges, which requires to create more sustainable food systems. The issues such as food availability, food safety, food recall, as well as food waste provide insight into Malaysia's overall food system scenario and how it is prepared to revamp and restructure its fundamental (Bujang and Bakar, 2020). Afiza and Soon (2014) claimed that the product recalls and other food-safety-related risks are becoming more popular in the agro-food industry. There are many issues and cases involved the product recalls and food safety in this sector especially in fruit and vegetable sectors. As a result, all parties involved should consider adopting smart technologies as a method to prevent unfavorable incidents such as the spread of a virus, infected meat and meat products, and food poisoning. Furthermore, there have been several cases and issues involving food safety that have been discovered by Malaysian authorities and reported by consumers. For example, there have been many cases in Malaysian supermarkets and retail stores where customers discovered non-Halal Deoxyribonucleic acid (DNA) in food manufacturer's ingredients. Fake Halal logos in establishments or on product packaging may also trigger distrust and a negative perception of the entire local food system (Samsi et al. 2012). These food crises and all negative cases affected both the supply and demand side of the food chain. This crisis drives the industry in adopting technological innovation

In addition, for the current issue in Malaysia, in the case of Covid-19, a new coronavirus strain, it has posed a threat to all economic sectors, especially agriculture. The Movement Control Order (MCO)1 in Malaysia initially triggered panic buying, resulting in a surge in demand for fresh food products at local markets and supermarkets. Simultaneously, the lockdown imposed to control the coronavirus outbreak has affected labor supply and disrupted supply chains in the agriculture industry (NST, May, 15th 2020). As previously mentioned, food security is multifaceted, encompassing factors such as food supply (supply), food accessibility (affordability), and food utilization (food safety and nutritional meals). Notably, the Covid19 crisis has already had an impact on food security and the food supply chain, both directly and indirectly, by influencing food supply and demand, shifting consumer behavior, and affecting food production and distribution capability (NST, May, 15th 2020). As a result of this massive development, players in the AFSC have been under constant pressure to increase visibility into their supply chains and develop new strategies to penetrate into new markets or business niches through food tracking and tracing (henceforth traceability) (Kumar et al. 2020). Businesses are under more pressure to provide details or information on product-specific attributes such as quality, safety, traceability, provenance (source or origin), and production and supply conditions (Boselie et al. 2003).

In addition, the adoption of Agricultural Revolution 4.0 in agro-food supply chain is at low level due to the several reasons which are higher costs (Ghadge et al. 2019, Zhang 2011, Fazel et al. 2010, Bhattacharya et al. 2015, Bhattacharya 2012), complexity of the technology including uncertainty about the functionality and infrastructure requirement (Ali and Thai, 2020, Bhattacharya 2012, Fazel et al. 2010), lack of resources, knowledge/awareness, technical expertise and capabilities from the top management initiatives and government regulations (Bhattacharya et al. 2015, Bhattacharya 2012, Das 2018, Ali and Thai, 2020, Ghadge et al. 2019, Hackius and Petersen, 2017), lack of support from stakeholders (Ghadge et al.2019, Saberi et al. 2019) and resistance to change (Walker et al. 2008, Zhu et al. 2012). Concerning about food security have developed in response to these challenges, guiding the industry toward the best ways of farming and introducing modern agricultural technologies for maximum benefits while preserving the environment for future generations (Luederitz et al. 2017). Businesses must be based on core competencies that will enable them to thrive in today's volatile and competitive climate. The adoption of technology became a crucial element for organizations to succeed and adapt to drastic developments in the business world. The adoption of Agricultural Revolution 4.0 (AR4.0) technology enable organizations to become one of problem-solver for SMIs to overcome the crisis and challenges. The aim of this study therefore is to generate the conceptual framework the relationship of pull and push factors as antecedents with the adoption of Agricultural Revolution 4.0 (AR4.0) technology.

1.1 Objectives
To generate the conceptual framework the relationship of pull and push factors as antecedents with the adoption of Agricultural Revolution 4.0 (AR4.0) technology.

2. Literature Review
2.1 Malaysian SMIs
SMIs, like developed countries, make significant contributions to the growth of exports, the creation of jobs, and the improvement of a country's GDP. According to the Malaysian Department of Statistics, SMIs account for nearly all

commercial establishments. Malaysia, on the other hand, has a higher proportion of SMIs in the service industry. SMIs are more important in Malaysia than large enterprises since they are more accountable for economic growth and development. Micro businesses are more prevalent in developing countries than small and medium-sized firms. According to Schapper (2006), more than 90% of SMIs in developing nations are categorised as micro. Similarly, the number of micro firms in Malaysia is higher than that of small and medium businesses. SMIs account for 99 percent of total business establishments, while large industry account for only 1% of total business establishments. Small and medium firms account for 27 percent of SMIs, but micro-industry account for 70 percent of all SMIs. Because of their more flexible structures than large businesses, SMIs are considered the backbone of economies and are important for political stability and social empowerment (Kayadibi et al. 2013, Radam et al. 2008). In Malaysian SMIs, there are some features that make such businesses highly significant in Malaysia. First, SMIs, which account for 99.2 percent of all business establishments in Malaysia and employ roughly 56 percent of the workforce, are the important source of growth for the country. They will be critical to Malaysia's new economic model, which strives to shift the country from a middle-income to a high-income economy. SMIs are defined according to their size, which is determined by sales, assets, or the number of employees. SMIs can thus be identified from major corporations and microenterprises using these parameters. However, there is no consensus on a single definition of SMIs. As a result, SMIs have been defined in different of ways in various contexts. According to Hashim and Abdullah (2000), SMIs in Malaysia can be differentiated into three main sectors such as manufacturing, business and agriculture. For various reasons, developing countries such as Malaysia values Small and medium-sized industries (SMIs) due to their potential to develop into larger industry, more productive units, capacity to develop and introduce emerging technology; and ability to respond to changing economic conditions (Berry, Rodriguez and Sandee, 2001).

2.2 Agro-Food Supply Chain (AFSC)

The supply chain is typically described as a network of organizations that participate in various processes and activities in the hands of the ultimate customer or consumer through upstream and downstream linkages, resulting in value in the form of products and services (Nee et al. 2015). Overall, Agro-Food Supply Chain is consisting of a set of operations such as input supply, output, post-harvest, storage, processing, marketing delivery, food services, and consumption that follow a 'seed-to-the-shelf' or 'farm-to-fork' sequence (Jaffee et al. 2010). Furthermore, they cross through the entire supply chain, including commodity manufacturers, suppliers, intermediaries, processors, exporters, retailers, and customers (Jaffee et al. 2010). Non-agricultural sectors such as manufacturing, transport, and steel production have historically dominated the literature on supply chain performance (Aramyan et al. 2006).

The supply chain for agro-food is similar to conventional supply chains, but with agriculture/horticulture as the product. Individuals from various organizations collaborate on various processes and activities to market products or services in order to satisfy customer demand in the agro-food supply chain (Christopher 2005). An agro-food supply chain can be described as a supply chain involved in the production and distribution of agricultural products, as well as the flow of information (Aramyan et al. 2006, Christopher 2005). The management of the supply chain is derived from three interconnected components which are: 1) management of activities and materials flow from supplier to producer and ultimately to customer through the process of transformation of raw materials into finished products; 2) information management through the supplier-manufacturer and manufacturer-consumer chains; 3) chain relationship management (Handfield and Nichols 1999). This includes the integrated manufacturing process where the finished products are manufactured from the raw materials and then shipped via distribution channel, retail or both to consumers (Beamon 1999). Hence, each and every organization is at least part of any supply chain or network that affects the supply chains, including the consequences towards natural environment through the derivation of operations and marketing decisions (Sarkis 2001).

2.3. Pull and Push Factor

Pull factors refer to the positive and favorable factors in adoption of agricultural revolution 4.0 that encourage continued implementation. is the need for certain technologies in order to achieve certain goals (Wolfert et al. 2017) while push factor refer to the enablers that will allow individuals or organizations to achieve higher or new goals (Wolfert et al. 2017).

Previous studies have suggested that pull factor is often emphasised in five important factors: strategy (S), technology readiness (T), organisation support (O), people (P) and environment (E) (Abu et al. 2014, Schuetz 2020, Manoharan 2018, Lindman, Tuunainen and Rossi 2017, Bonekamp and Sure 2015). Meanwhile, previous studies implied that the push factor is often pointed out in five significant factors; food security (S), food integrity (I), food safety (S), food waste (W) and food availability (A) (Scholz et al. 2015, Pieters et al. 2013, Galvez, Mejuto and Simal-Gandara 2018, Creydt and Fischer 2019). They are summarised as follows:

-S: The integration of an organization's internal strengths with external opportunities and challenges
-T: The trait-like individual difference variable that captures people's general attitude toward accepting new technologies
-O: Managerial beliefs about technological initiatives, participation in those initiatives, and the extent to which top management advocates technological advancement
-P: The participation of stakeholders who encourage the organisation to commit in adopting the technology
-E: The organization's surroundings, determining how external factors affect a firm's desire to adopt a technology

-S: The measure of the availability of food and individuals' ability to access to it
-I: The state of being whole, entire, or undiminished or in perfect condition
-S: The prevention of food contamination prior to its being released to the consumer by ensuring that all foods made available for sale and consumption
-W: The decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers
-A: The presence and supply of food through production, distribution, and exchange

2.4 The Agricultural Revolution 4.0 (AR4.0)

The concept of Agriculture 4.0 has gained large popularity and importance since it was first introduced by the German. According to CEMA (2017), there are different terms frequently used to refer to Agriculture 4.0, such as “Smart Agriculture”, “Intelligent Agriculture” and “Digital Farming”, or “Digital Agriculture”, as well as multiple perspectives from which the concept of Agriculture 4.0 is examined and explained. The concept of Agriculture 4.0 is an implementation of Industry 4.0 methods in the agricultural sector (Zambon et al. 2019, Braun, Colangelo and Steckel 2018, CEMA 2017, Perez-bedmar 2018).

Despite the fact that the revolution was intended for the manufacturing sector, it can also be implemented to the agricultural industry. In truth, the agricultural industry has gone through various stages of revolution (Mat Lazim et al. 2020). According to Dung and Hiep (2017), the first stage, which began in the early 20th century, is characterized by low productivity and a labour-intensive farming system. The Green Revolution, the second stage, is characterized by efficient agronomic management approaches with higher yield potential and increasing returns to scale at all levels. The third stage is characterized by farming industries that are more efficient and profitable, resulting in higher product quality. The fourth stage, pronounced as IR4.0, occurred in parallel with a similar evolution in the industrial world. Agricultural revolution 4.0 (AR4.0) is a term that refers to a farming operation's integrated internal (within the farm) and external (outside the farm, which includes suppliers, customers, service providers, and so on) networking. The digital information from all farm sectors will be electronically collected, processed, communicated, evaluated, and shared with all people involved in the supply chain as part of this revolution (Dung and Hiep 2017).

Agriculture 4.0 is creating a new agricultural field which will depend on data acquisition and sharing along the entire supply chain (Brettell et al. 2014, Barata et al. 2018). At the same time, Agriculture 4.0 is a new method to connect the digital world with the physical world. In addition, Oesterreich and Teuteberg (2016) stated that Agriculture 4.0 can be described as an environment which is increased digitilisation and automation in addition to an increased communication enabled by the creation of a digital value chain” (Oesterreich and Teuteberg 2016). According to Pereira and Romero (2017), the term of Industry 4.0 or Agriculture 4.0 is an “umbrella term for a new industrial paradigm” and it consist of Cyber-Physical System (CPS), Internet of Things (IoT), Internet of Services (IoS), Robotics, Big Data, Cloud Manufacturing, Augmented Reality and many more.

Agriculture 4.0 evolves in conjunction with similar developments in the industrial sector, namely Industry 4.0, which is based on a concept for future production (Zambon et al. 2019). Agriculture 4.0, like Industry 4.0, refers to the internal and external connectivity of farming activities, as well as the delivery of digital data across all farm sectors and processes. The 4.0 revolution is a great opportunity to understand the variability and ambiguity associated with the agri-food supply chain in agriculture, even as it is in the industrial sector (Deichmann, Goyal and Mishra 2016).

Due to the extreme combination and integration of production technology and devices, information and communication systems, data and services in network infrastructure, factories become smarter, more effective, healthier, and more environmentally friendly (Adnan et al. 2018). A constant communication between market and production and within the company itself is one of the key needs that to be met (O'Grady and O'Hare 2017). Today, the farm's technical equipment has reached a level comparable to industry. Developing data use declares a digital agricultural revolution driven by several developments in agriculture (Deichmann, Goyal and Mishra 2016). Subsequently, the agricultural data provide a major driver is not only for output and food chain revolutions, but also of environmental management (Caron, Bianabe and Hainzelin 2014). Current industry's transformation into a smart chain is the keystone of the new millennium industry. Agriculture 4.0 technologies such as mobility, cloud computing, IoT, Artificial Intelligence (AI) and big data analytics are enabling a future of "smart everything" and "Internet of Everything".

3. Methodology

A variety of documents were reviewed for this conceptual paper, and data were collected from records, articles, journals, and original research papers. The information gathered was organized and compiled in order to be interpreted. The arguments of many researchers were taken into consideration, and the reviewer supports accordingly and made interpretation.

4. Conceptual Framework of Adoption of Agricultural Revolution 4.0 Technologies

As we mentioned on the introduction above, the push and pull factors are highly related with the adoption of Agricultural Revolution 4.0 (AR4.0). Adoption of agricultural revolution 4.0 (AR4.0) technologies is influenced by several interrelated components within the decision environment in which farmers and entrepreneurs operate.

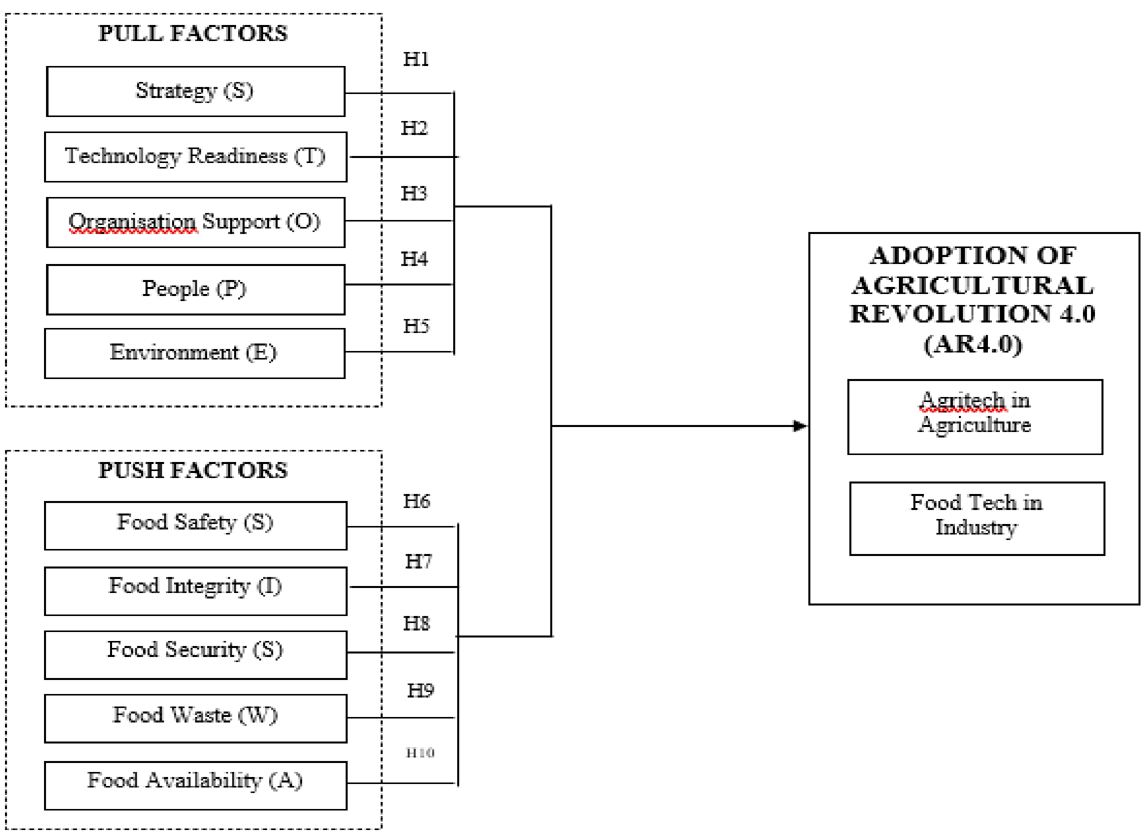

Figure 1. Conceptual Framework

The Figure 1 above shows the framework between the Push and Pull Factors towards the Adoption of Agricultural Revolution 4.0 (AR4.0)

4.1 Pull and Push Factor as the Antecedents of adoption of Agricultural Revolution 4.0 (AR4.0)

Pull factors refer to the positive and favorable factors in adoption of agricultural revolution 4.0 that encourage continued implementation. is the need for certain technologies in order to achieve certain goals (Wolfert et al. 2017). There are five pull factors which are (i) strategy, which involves the plan of making decisions about an organization's future that establishes and reveals the organization's objectives and goals for achieving them; (ii) technology readiness, which reflects technical processes, competencies, and infrastructures that support the technology adoption; (iii) organisation support, which include the involvement of human capital and its environment that promotes the technology adoption; (iv) people, which involves the participation from the stakeholders have considerable effect towards successful adoption of AR4.0, (v) environment, which explores the organization's surroundings, determining how external factors affect a firm's desire to adopt a technology.

Push factor refer to the enablers that will allow individuals or organizations to achieve higher or new goals (Wolfert et al. 2017). The push factors considered include (i)food security, which including both physical and economic access to food that meets people's dietary needs; (ii)food integrity, which is about reliable food exchange; (iii)food safety, which entails requirement for hygienic food production, management and storage in order to prevent diseases from arising food waste and food availability; (iv)food waste; (v)food availability, which comprises the degree to which food is within reach of households, through local development or local stores and markets, households.

Strategy reflects the process of goal setting and how top management exerts their control to ensure feasibility (Choi et al. 2016). Strategic planning is being used by organisations to determine strategy and drive resource allocation decisions in order to achieve their goals. According to Jayashree et al. (2019), the Agricultural Revolution 4.0 adoption is significantly linked to the business strategy. This dimension includes the AR 4.0 roadmap (Schumacher et al. 2016), which should be implemented in collaboration with the technical advisory panel; the relevant improvement and research activities, as well as their support, will be accepted and synchronized from a business point of view. Therefore, we propose hypothesis:

H1= Strategy have a positive impact on AR4.0 adoption

Technology readiness was described by Parasuraman (2000) as "the propensity of people to embrace and use new technologies to achieve goals in home life and at work". It is noted that organizations with higher technology capabilities would be more likely to embrace and adopt digital technology. Crosby et al. (2016) has made great strides by testing the influence of technological competence on adopting technology and was found to be a significant determinant of technology adoption and can provide companies with the ability that can help them to facilitate the adoption of agricultural revolution 4.0 technology. This result is consistent with a study by (Brown and Russell 2007), where the authors found that technology competence positively affected digital technology adoption intention. Thus, we propose:

H2= Technology Readiness have a positive impact on AR4.0 adoption

Organisational support refers to the circumstances such as willingness from the point of view of managers to provide support or barriers (Yeh and Chen 2018) and are used to signify whether or not the organizations have the source of technological and financial for strategic investments. The new technology is more likely to be successfully adopted by employees and integrated into the business of an organization if the employees understand the benefits of its use and are assisted by their superiors (Ilin et al. 2017). Extra support from organization which are top management might be significant to emphasize the commitment of resources and the cultivation of organizational culture are conducive to successful AR4.0 adoption. Therefore:

H3= Organisation support have a positive impact on AR4.0 adoption

People factor in a firm is related to human resources, training and education, skills and experiences (Lian et al. 2014). The higher the involvement of people is, the more likely to succeed in adoption and utilization of technology under Agricultural Revolution 4.0 (AR4.0). These people have considerable influence over the decision-making process, work implementation, and roles and responsibilities, and therefore have a significant impact on the organization's readiness to change. The stakeholders which involved in agri-food supply chain (AFSC) may collaborate more easily and effectively with the technology, increasing trust in business interactions. Accordingly:

H4= People have a positive impact on AR4.0 adoption

Environment reflects external drivers of the organisation i.e., the extent of regulatory and the environmental pressures that influence technology adoption (Zhu and Geng 2013). The environment represents the organization's surrounding and encompasses the market, rivals, relations with government and public administration. In this respect, Premkumar and Ramamurthy (1995) made a strong point by discovered that companies would embrace emerging technology due to internal pressures and a desire to achieve a competitive advantage. Osakwe et al. (2016) have argued that government support in the form of the provision of critical infrastructure and friendly legislation may be considered to be a stimulus for firms in developing countries to adopt AR4.0. If not, government policies may bring uncertainty and risk (Abualrob and Kang, 2016). Therefore, this plausible to derive the following hypothesis:

H5= Environment have a positive impact on AR4.0 adoption

The Food and Agriculture Organization (FAO) defines food security as the situation when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". A wealth of studies indicates that there is a positive correlation between agricultural innovation and food security. Technologies increase agricultural productivity gains and lower production costs per unit, with the impact of increasing farmers' incomes and shifting the supply curve outward, which (depending on demand elasticity) may lower food prices (Kassie et al. 2011). Thus:

H6= Food Security have a positive impact on AR 4.0 adoption

The food integrity can be enhanced by greater traceability (Galvez, Mejuto and Simal-Gandara 2018, Creydt and Fischer 2019). Business organizations may mitigate food fraud through the application of AR4.0 technology by easily detecting and tracing outbreaks back to their specific origins (Levitt 2016). Thus, we propose:

H7: Food Integrity have a positive impact on AR 4.0 adoption

The focus of a society that is increasingly worried about what they consume and where the goods come from has been food safety. Many individuals no longer comply with food products and their supermarket information, but still want to ensure that what they consume comes from reliable sources and that there is no opacity or tampering in the product information (Tipmontian et al. 2020). The study by Tipmontian et al. (2020) found that the degree of consumer awareness of food safety is one of the important factors that can influence the product's designation in order to increase the adoption level of technology. Consequently, the following hypothesis is proposed:

H8: **Food Safety have a positive impact on AR 4.0 adoption**

Food waste is a major global issue that not only has economic but also environmental and social consequences (Scholz et al. 2015). Numerous different types of technologies have a high potential in reducing and minimizing food waste along the supply chain, as stated by recent literature on food waste (Gustavsson et al. 2011, Aramyan and Valeeva, 2016, Canali et al. 2017). The importance of developing new ways to avoid and/or minimize food waste has been emphasized (Canali et al. 2017). The implementation of new technologies to improve storage, such as smart climate control systems to preserve perishable goods, improved refrigeration equipment, and control management, such as the new intelligent fridges and freezers that can display the content and expiration date of specific food items. This including the use of new intelligent scales and statistics systems to better quantify the food waste along the chain, as well as the adoption of better measurement systems to quantify the food waste along the chain and to minimize the food waste (Grunow and Piramuthu 2013). Therefore:

H9: **Food Waste have a positive impact on AR 4.0 adoption**

Food availability is defined as the presence of food through all forms of domestic production, commercial imports and food aid (WFP 2012). According to Just (1985), agricultural revolution 4.0 (AR4.0) technologies increase the availability of food by raising crop productivity, increasing the supply of food per unit of agricultural land, maintaining local and general domestic food production growth, and contributing to the development of the agricultural sector. Apart from that, Kassie et al. (2011) pointed that the food available is enabled by agricultural technologies because higher productivity and lower production costs increase crop income for farmers, increase food expenditure and, potentially, increase their intake of calories and micronutrients. This led to the hypothesis:

H8: **Food Availability have a positive impact on AR 4.0 adoption**

5. Conclusion

Agricultural revolution 4.0 (AR4.0) technology is a vital strategy for boosting agricultural production, establishing food security, and relieving poverty and food insecurity among Malaysian's farmers and entrepreneurs. The entrepreneur and farmers have been embracing and adopting many agricultural technologies, albeit the adoption of these technologies has not yet reached its peak capacity. As a result, it is necessary to continue to promote agricultural new technologies among them. The push and pull factors are all factors that have a substantial impact on farmers' adoption of agricultural revolution 4.0 (AR4.0) technology. The study is expected to contribute and help the industry by providing the framework as a guide for understanding the influence of antecedent which are pull and push factor on the implementation of AR4.0 that can lead to improve the sustainability in agricultural performance and eventually achieve higher business performance.

6. Future Research

The conceptual framework explaining the proposed relationship between the pull and push factors and the adoption of Agricultural Revolution 4.0 (AR4.0) in SMI, and performance and sustainability elements later will be continued as further study to be tested using survey questionnaire data collection and quantitative study methodology, particularly Structural Equation Modelling (SEM). In future research, it could be worthwhile to look at this subject from a broader perspective of innovation.

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