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Push and Pull Factors of Industrial Revolution 4.0 (IR 4.0) Adoptions for Resilience and Sustainable Food Supply Chain Among Food SMEs in Malaysia with Relationship Orientation as Moderator

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Abstract - **To show that SMEs in the food industry are rapidly implementing IR 4.0 and to support organizations that have already started using IR 4.0 with plans to boost performance. This study investigates why IR 4.0 adoption happened and which factors brought it about. Because of this, operations managers and other IR practitioners will be better prepared to comply with the coming new law and policy which will apply to Malaysian supply chain organizations. The findings is to have a significant impact on overall awareness and knowledge of IR4.0. Firms in supply chains received economic benefits from IR 4.0 implementation and a long-term economic viability of the process was discovered. Malaysian supply chain organization's sustainability is anticipated to rise as a result of the implementation of IR 4.0, allowing it to contend globally. This study presents findings about the current quality of IR 4.0, which contribute to the development of a roadmap for advancing IR 4.0. Social sustainability, as well as government traceability regulations and emerging food security technology, rely heavily on food safety. The long-term sustainability of the economy can benefit from this study.**

Keywords – **Industry Revolution 4.0; SMEs Performance; Resilience; Sustainability**

I. INTRODUCTION

The current global business environment is more competitive and challenging, therefore, the application of IR Revolution 4.0 (IR 4.0) concepts into practice in the entire manufacturing environment is complex, particularly for Small and Medium Enterprises (SMEs). Generally, there is a supportive environment to the IR 4.0 adoptions for food supply chains in Malaysia [3]. This study provides an attractive case by pointing out that even when the supportive environment is provided, the low adoptions of IR 4.0 among SMEs could still impact the overall outcomes especially on the SMEs' sustainable competitiveness which be influenced by some significant factors. Given this situation, the IR 4.0 adoption for food supply chains is an interesting issue to study. Accordingly, this study is keen to identify the pull and push factors of IR 4.0 adoption and the outcomes of these technologies on firms' resilience performance and sustainable competitiveness.

The implementation of IR Revolution 4.0 (IR 4.0) has shifted the world's attention to sustainable development and that effort should be given serious attention because the natural world cannot be harmed in the future by exploiting it. The process of exhausting all available resources while producing a large amount of waste and pollution is known as resource exploitation [1]. As a result, sustainable practices can be considered as one of the solutions for SMEs to promote, innovation, waste management, renewable energy, energy efficiency, sustainable storage practices and water savings that consequently drive the SMEs to achieve their competitive capabilities in cost, quality, delivery, and flexibility [2]. Hence, it is critical for SMEs food supply chain to maintain their economic viability in order to help mitigate the problem by engaging technologies in their activities that benefit not only the economy but also the environment and society.

Accordingly, the following subsections will begin with discussion on the food supply chains by describing how IR 4.0 application is integrated into the SMEs food supply chain operation in food Industry Revolution 4.0 in global and Malaysian context. The main goal of these subsections is to provide motivation for the study by focusing on the challenges of the food supply chains which is the most difficult to manage since its products suffer from short shelf-life. Besides, the evolution of technology applications related to the food supply chains shall be overviewed. In sum, the current trends of the food supply chains shall be overviewed with particular focus on the application of IR 4.0 among the SMEs in the food supply chains. The ineffectiveness of the food supply chain is mainly related to two aspects from one perspective, it is disruptions and dynamic environment whereas from the other perspective, it is the length of the supply chain and the necessity to make

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trade-offs between sustainability and cost-effective performance [29].

There is a need to improve SMEs' knowledge and techniques on new technology for them to survive [26]. Concerns about supply chain have guided SMEs toward the best practices and introducing modern technologies to increase productivity while protecting the business for future generations [7]. The manufacturers of food, beverages and agricultural products must keep up with technological advances. The use of digital equipment and technological advancement would help to increase of agricultural productivity [32]. The supply chain of the food Industry Revolution 4.0 is complex as there are many players of SMEs consists of suppliers or farmers, production or processing plants, a wholesaler, retailers, and supermarkets facilities [21]. Some of the food supply chain is applying the traditional supply chain approach which requires extensive storage time and delivery time of food products. Additionally, larger supply chain players may also seek to keep costs low by exploiting the capabilities of food supply chain technologies [8]. Because of technological advances, international supply chains are becoming increasingly efficient and cost effective, requiring less labour and fewer mistakes throughout the chain, while also becoming more responsive to market demands. Adoption of technology will contribute to and resolve issues, particularly in the field of food supply chain. To support and close the gap for SMEs, a range of approaches have been identified, including the factors influencing IR 4.0 adoptions [40].

There is extensive research into the adoption factors have been conducted but still need more information whether which adoptions factors for which technologies features. In conjunction to the factors, the study is also interested to look at the outcomes of the IR 4.0 adoptions on the resilience performance and the notion that constant disruptions positively influence the resilience of the food industry [22]. The study of the effect of relationship orientation is importance to the adoption of IR 4.0 because IR 4.0 can be classified based on the principles of integration into vertical, horizontal and end-to-end integration of the supply chain [11].

II. LITERATURE REVIEW

The literature is conducted to identify the theoretical gaps. The variables in the framework are then thoroughly discussed to justify the variables of the study especially on the pull and push factors of the adoptions, the adoption of IR4.0, the outcomes of IR 4.0 adoptions from the aspects of business resilience performance and substantiality business performance including the relationship orientation as the moderator.

2.1. Food Supply Chain Management

Today, market condition changes rapidly due to the obvious effects of globalisation as well as sociological, technological, fiscal and political factor [7]. Food and agriculture are both fundamental in shaping food security where the food produced by farmers and fisherfolk sufficiently supply and satisfy the population [32]. Generally, the quality and quantity of food determines food security in terms of utilisation and nutrition outcomes [9]. Food security is defined by four important factors such as food availability for consumption, physical and economic access by purchasing or producing food, food utilisation for human nutrition and stability of food supply in relation to sudden shocks and cycles [28]. In other words, a population has a high level of food security when it is able to obtain sufficient food from reliably stable and adequate food supply at affordable prices to meet its consumption needs and nutritional requirements.

As a result of this rapid growth, food industry players have been under constant pressure to increase visibility into their supply chains and develop new strategies for expanding into new markets or establishing new market niches via food tracking and tracing from farm to retail [19]. Furthermore, end users have become more educated and have come to expect real-time news and information via digital media. They are becoming increasingly concerned about whether the foods they consume are environmentally and socially sustainable [37]. As a result, food product traceability, safety and sustainability concerns have risen to the top of the priority list for food retailers, distributors, processors and farmers [14], who's digital and technology skills are still lacking. There are tensions between supply chain players over how to reduce costs by leveraging supply chain digitization to make more efficient decisions based on rich data analytics [8], or the digital integration of supply chain operations in order to eliminate waste, inefficient labour and excess inventory [37].

2.2. Push and Pull Factors of Industrial Revolution 4.0 (IR 4.0)

The Input-Process-Output Model (IPO) has three stages: input, process and output. The inputs are treated as consumables with attempts starting during the lifecycle of a system. Outputs are represented as the system's output and the processing as the conversion of the inputs to the outputs [13]. Because the model considers IR 4.0 such as processes and the consequent ramifications also it helps answer the study's research questions such as outputs. Furthermore, it considers the antecedents as inputs of balanced and adoptions processes at various levels of analysis for each process. The TOE framework to acquire a more comprehensive understanding of the many influencing factors behind the shipbuilding industry's adoption of I4.0 Cyber-Physical Systems technologies [39]. The TOE framework allows for the evaluation, at various levels, of how different aspects may ultimately influence the adoption of an information technology-related technology. Adoption of IR 4.0 is supported by pull factors positive factors that aid adoption while push factors enablers that enable individuals or organisations to reach better or new targets act as enablers [14]. The need-pull innovations have been found to be characterized by

higher probabilities for commercial success than have technology-push innovations [43]. Pull factors refer to the enablers related to the needs of these technologies to achieve higher or new goals or in achieving certain goals [41]. Outcomes are defined in this study as the positive results or consequences that are actually realized from the adoption of IR 4.0 by SMEs. This study is concerned with the major IR 4.0 which have a significant connection with the production and services of SMEs and increase the performance.

2.3 Business Resilience Performance

The supply chains need to manage resilience in order to be sustained. By linking resilience theory with the sustainable transition process of organizations, this study attempts to explore opportunities to the diffusion of IR 4.0 from an integrative perspective. Resilient systems do not fail in the face of adversity instead, they adapt. Adaptation can be rapid or gradual, depending on the type of disturbance. Taking measures to improve supply chain resilience helps organizations to meet their strategic goals [42]. Managers can thus build a portfolio of capabilities to address critical resilience gaps and boost overall competitiveness. Consequently, this study works toward a unified Organizational Resilience Theory (OTR) to help embrace and manage organizational change effectively when considering the technologies on how organizations might achieve greater resilience from adoptions of IR 4.0 [21]. Supply chain resilience also represents a business opportunity that must be capitalized on in order to avoid risk [35]. There is disruptive resilience supply chain that significant can impact on the business, particularly in the adoption of IR 4.0 [17]. There are widely accepted belief that a supply chain manager's priority must solely be to minimize cost and optimize efficiency, while also including risk mitigation strategies [24]. Supply chains are at risk of disruption as global markets continue to be volatile [5]. The highlighted that the firms must be resilient in order to recover quickly [23].

2.4 Business Sustainable Performance

There are various concepts have been proposed in recent years with the specific intention of incorporating the vision of sustainability into business practices. These concepts involve the management of information and material flow across supply chains, as well as product life cycles, from one organisation to another. When defining the supply chain's strategic objectives and key processes, the stakeholders in the system must be taken into consideration [25]. Sustainability is most often associated with the implementation or fulfilment of the three pillars of sustainable development, also recognised as the Triple-Bottom-Line (3BL) concept [38].

2.5 The Concept of Relationship Orientation

The proactive establishment, development, maintenance and enhancement of close, long-term inter-firm relationships is referred to as relationship orientation [33]. A close relationship implies that supply chain partners share information, risks and benefits as well as being completely reliant on one another and willing to maintain the relationship over period [31]. This relationship is more than adversarial transactional exchanges and repeated purchases, it is based on trust, mutual benefit, commitment, communication, and cooperation [6]. According to the preceding discussion, relationship orientation refers to an organizational culture that places a premium on building strong, long-term relationships over transactional ones. This mindset entails viewing the partner as an extension of the firm and working closely with the firm to accomplish mutual objectives [27].

III. CONCEPTUAL FRAMEWORK

The objective of this research is to investigate the effect of the IR 4.0 adoption or diffusion within firm. This means that the study centers on the use of IR 4.9, which is a focus for this research. This design is also consistent with prior research done on IR 4.0. The study found various variables and dimensions of the main constructs of the study (IR 4.0, drivers, outcomes and relationship orientation). Also, the theoretical basis of the study explains how these constructs are interconnected. To explain, the study's theoretical framework takes into consideration variables and relationships in Figure 1:

H1 = The Pull factors have positive effect on adoption on Industry Revolution 4.0 (IR 4.0)
H2 = The Push factors have positive effect on adoption on Industry Revolution 4.0 (IR 4.0)
H3 = The effects of the pull push factors on adoption Industry Revolution 4.0 (IR 4.0) are stronger when relationship orientation is higher
H4 = The adoption Industry Revolution 4.0 (IR 4.0) are positively affected the business resilience performance
H5 = The adoption Industry Revolution 4.0 (IR 4.0) are positively affected the business sustainable performance
H6 = Business resilience performance have positive impact on business sustainable performance
H7 = The effects of mediating business resilience performance on adoption Industry Revolution 4.0 (IR 4.0) and business sustainable performance.

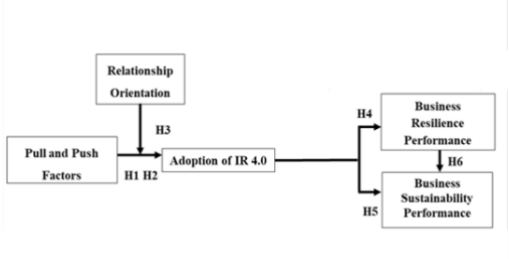

Figure 1. Conceptual Framework

3.1 Antecedents of IR 4.0 Adoptions

The pull factors refer to enablers associated with these technologies' requirements to achieve higher or new goals or to accomplish specific goals [41]. IR 4.0 adoption can lead to social sustainability by increasing food safety. According to the research of [32], implementation of smart technology is key in maintaining food safety and agriculture sustainability. According to the study, using intelligence in crop factories helps to improve product traceability and employee quality of life. Preventing pests and pesticides can ensure food safety.

H1= The Pull factors have positive effect on adoption on Industry Revolution 4.0 (IR 4.0).

A digitalized era in which machines, devices and consumer items can be interconnected to adapt and be flexible in response to market changes is being ushered in by the connectivity platforms provided by new technology. In this regard, the IR 4.0 trend is primarily based on a technology-push innovation approach, as it originates from direct competitors with a common goal of improving productivity and efficiency [10].

H2= The Push factors have positive effect on adoption on Industry Revolution 4.0 (IR 4.0).

Customer relationship orientation enhances a company's ability to coordinate marketing and service strategies in order to achieve and maintain long-term partnerships [15]. Supplier relationship orientation is the practice of planning, implementing, developing and monitoring company relationship with the current and potential supplier [36].

H3= The effects of the pull push factors on adoption Industry Revolution 4.0 (IR 4.0) are stronger when relationship orientation is higher.

3.2 Outcomes of IR 4.0 Adoptions

Food safety methods and technologies are required at all levels to prevent the spread of the virus [12]. Firms capable of investing and making decisions [20] can influence sustainability and company performance, which in turn affects their involvement in emerging technology, such as blockchain, 3D printing solutions, automation and so on. A lot of evidence suggests that risk effects can impact sustainable and business performance by IR4.0 adoption.

H4= The adoption Industry Revolution 4.0 (IR 4.0) are positively affected the business resilience performance.

Several theoretical explanations for long-term agricultural performance have been proposed in the literature. Using technology in supply chains can assist with product quality verification, business process distortion and contracts signed between supply chain partners [16]. The supply chain disintermediation improved economic performance, lower transaction costs, data security and authentication and increased transparency will significantly reduce transaction costs [30].

H5= The adoption Industry Revolution 4.0 (IR 4.0) are positively affected the business sustainable performance.

The formalized supply chain partners frequently pay for product quality verification, business process distortion and signed agreements. However, using technology can cut out these costs [16]. Technology adoption leads to supply chain disintermediation, improved economic performance, lower transaction costs, data security and authentication and increased transparency throughout the supply chain. Firms could improve their sustainability efficiency by streamlining business processes and making the entire supply chain more responsive and efficient.

H6= Business resilience performance have positive impact on business sustainable performance.

The resilience concept would then be implemented in a firm to assess its applicability [4]. It would detect flaws and missing components while also emphasising the approach's usability and how well organisations can adapt the model to their specific needs. Having said that, resilience capabilities such as IR4.0 can be enhanced through close collaboration between various departments within a business and its supply chain partners [11].

H7= The effects of mediating business resilience performance on adoption Industry Revolution 4.0 (IR 4.0) and business sustainable performance.

IV. CONCLUSION

The study focuses on the use of Industry Revolution 4.0 (IR 4.0) in food Industry Revolution (IR). Because the sector makes a significant contribution to the Malaysian economy, efforts from IR 4.0 would improve the competitiveness. The study focused on Malaysian small and medium-sized businesses involved in the food supply chain. The study conceptualised the push and pull factors of IR 4.0 adoptions as antecedents and outcomes on the organization's efficient use for more resilience and sustainability in the food supply chain. The study focuses on process-based IR 4.0 adoption initiatives rather than product-based ones. The study focuses on the initial acceptance and take up (internalisation) of IR 4.0 adoptions by focusing on adoption. The emphasis on IR 4.0 adoption or initial take up is consistent with the overall objective of the research, which is to determine how IR 4.0 adoptions are generally distributed among SMEs in food IR.

The study is intended to be cross-sectional in nature, focusing on the analysis of organisational business at a single point in time. The framework of the study can be divided into two parts. In the first stage, two independent variables, namely pull and push factors, are postulated to have an impact on their respective dependent variables, which are IR 4.0 adoptions. In the second stage, IR 4.0 adoptions then alleged to influence the firm's resilience and sustainability performance. Adoptions of IR 4.0 as independent variables would have an impact on resilience and sustainability performance. The study's antecedents of pull and push factors, as well as its outcomes on resilience and sustainable food supply chain performance, are expected to have an impact on future research in IR 4.0. Such the study on the antecedents and outcomes of IR 4.0 is critical because the current literature must be critically analysed based on current evidence from an academic perspective in order for stakeholders to develop an effective implementation strategy. From the concept's antecedents and outcomes, there are strategic implications that can be assessed in this push and pull factors of industrial revolution 4.0 (IR 4.0) adoptions for resilience and sustainable food supply chain among food SMEs in Malaysia. The study's population consists of Malaysian SMEs' managers. The variables for this study were measured using adaptations in the literature of previously used measures as well as self-constructed items with some modifications taken from previous literature in the similar field of research study. The unit of analysis of the study is an organisation made up of small and medium-sized enterprises (SMEs) operating in the food supply chain IR in Malaysia. SMEs in the food supply chain were chosen because they are expected to be best positioned to adopt IR 4.0. Thus, SMEs need to be nurtured on the importance of moving on to IR 4.0 rather than maintaining themselves in conventional business.

As a result, there is a need for an academic study that compiles and analyses the antecedents and outcomes of IR 4.0 adoption in organizations, so that stakeholders are well informed. Furthermore, understanding the antecedents and outcomes will assist organizations in successfully deciding on its adoption. A systematic literature review is planned to capture the academic perspective of IR 4.0 in terms of antecedents and outcomes. In terms of theoretical contribution, this study supports theoretical understanding in IR 4.0 adoptions from the perspective of Davis's (1998) Input-Process-Output Model (IPO), the push and pull factors from the perspective of Technology Pull-Push Motivation Theory (TPPM), and resilience performance from the perspective of Organizational Resilience Theory (ORT) (SET). Increasing the number of theories as underlying logical arguments for the variables' relationships will thus significantly improve IR 4.0 theoretical development. This study will provide evidence to assist existing adopters in integrating IR 4.0 as part of a strategy to improve organizational and business performance, as well as inspire SMEs in the food IR to implement IR 4.0. This study includes practical implications that will assist policymakers in better understanding and improving policies that help SMEs grow and compete if they want to expand and improve their market competitiveness.

Some of the limitations in this research are as follows. First, the limitation of the study is that it is restricted to SMEs, despite the fact that rapidly changing markets and uncertainties affect not only the SME industry but also other existing industries. As a result, future studies should broaden the scope of research to include SMEs as well as larger corporations. Second, the conceptual framework testing method is the only one that was used in this research. With the help of quantitative methods, future research should be able to put the conceptual framework developed in this study to the test. Researchers in the future may be able to obtain more complete results if they implement qualitative testing methods in their studies.

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