INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 13, Issue 11, (2023) E-ISSN: 2222-6990

Exploring Impacts And Challenges Adopting Industrial Revolution 4.0 Among Manufacturing Small Medium Enterprises (SMEs) In Malaysia

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v13-i11/19540 DOI:10.6007/IJARBSS/v13-i11/19540

Published Date: *26 November, 2023*

Abstract

The study is set in the 21st century business landscape, where executives emphasize productivity and value addition in a highly competitive market. IR 4.0 is presented as a solution to optimize business operations, decision-making, and communication through technologies such as robotics, big data analytics, IoT, cyber-physical systems, and virtual networks. The Fourth Industrial Revolution is believed to hold positive impacts not only for large-scale businesses but also for SMEs. SMEs in developing economies, including Malaysia, are striving to adopt IR 4.0 to enhance their business ecosystem and remain competitive. However, the state of adoption IR 4.0 among manufacturing SMEs in Malaysia remained unknown. Hence, the study's objective is to investigate the impacts and challenges of IR 4.0 adoption among SMEs in Malaysia. The chosen research methodology is qualitative, employing face-to-face interviews with 20 manufacturing SME owners in Johor. Purposive sampling is used to select participants. The results of the study indicate that manufacturing SMEs owners in Malaysia recognize the positive impacts of adopting IR 4.0 on their businesses, the economy, and society as a whole. However, the main challenges they face are

internal aspects of their companies and their employees. These challenges include financial constraints (cost) associated with adopting IR 4.0 technologies and employees lacking the necessary knowledge and skills to work with such technologies. The study suggests that the government should take more actions to promote the adoption of IR 4.0 at the grassroots level. This could involve providing technical, financial, and consultative support to SMEs to overcome the obstacles they face. Additionally, preparing a skilled workforce is essential. The education system should incorporate relevant skills and knowledge related to big data analytics, machine learning, robotics, and business model transformation in alignment with IR 4.0 technology.

Keywords: Fourth Industrial Revolution (IR 4.0) , SMEs, Manufacturing,

Introduction

Fourth Industrial Revolution 4.0 (IR 4.0) is at the centre of many advanced visions by the organizations and businesses leaders (Lichtblau, 2015). IR 4.0 refers to the potentials of advanced technologies including IoT, Big data, robotics, Machine learning and cloud computing (Nagy, 2018) which empowers the automation and digitisation of the manufacturing sectors through embedding sensors in the products, components and manufacturing equipment in order to perform simultaneous analysis of data during the manufacturing process (Zakri,2017). IR 4.0 represents the ways in which the smart and connected technologies engrained within the organizations and business (Deloitte Development LLC, 2018). In fact, it can completely transform the living styles and future of work patterns and changing the value of global society (Park, 2016). Many developed countries have adopted IR 4.0 particularly in business to make business process faster and enabled the effective integration with their suppliers and customers (Wahl, 2015; Pessl, Romina, & Mayer, 2017; Mubarak M.F. et al., 2019).

In Malaysia, the former Prime Minister recognized the potential of IR 4.0 to contribute to the success of the National Transformation 2050 vision. This indicates that IR 4.0 is seen as a crucial driver for the country's long-term development. The Federation of Manufacturers (FMM) highlighted that most manufacturing organizations and businesses in Malaysia are aware of the significance of IR 4.0. This awareness underscores the recognition of technological advancements in the business landscape. To maintains Malaysia's competitiveness in the global context with IR 4.0, the Ministry of International Trade and Industry (MITI) established a High-Level Task Force (HLTF) in March 2017. The HLTF is responsible for developing a comprehensive government strategy for IR 4.0, incorporating industry feedback. The IR 4.0 HLTF comprises five Technical Working Groups (TWGs), each focusing on specific aspects such as digital infrastructure and ecosystem, funding and incentives, talent and human capital, technology and standards, and support for Small and Medium-Sized Enterprises (SMEs). These groups identify challenges, analyze gaps, and propose actions for inclusion in the National Policy on IR 4.0. The budget for the year 2019 underscored the importance of adopting IR 4.0, particularly among SMEs. This financial emphasis indicates the government's commitment to supporting technological advancements at all business levels. These initiatives demonstrate Malaysia's proactive approach to embracing IR 4.0 and ensuring that the country remains competitive in the global economic landscape.

Despite the recognition of the importance of IR 4.0, it's argued that the implementation has been slow in Malaysia (Abdullah & Salleh, 2017). The Ministry of International Trade and Industry (MITI) has claimed that Malaysia's relatively small population might be a factor in the

slow adoption of high technologies associated with IR 4.0. Additionally, there's a shortage of IR 4.0 experts, including engineers, robotic engineers, and mechatronic engineers, which impedes the full implementation of automation and IR 4.0 initiatives (Othman, 2016). To address these challenges and steer Malaysia in the right direction, the former Prime Minister launched the Policy on Industry 4.0, known as Industry 4WRD. This national policy places a strong focus on skills development as a key enabling strategy. This emphasis on skills development is vital to ensure that Malaysia's workforce aligns with the requirements of IR 4.0 while also creating a balance in job opportunities. These insights highlight the complexities involved in transitioning to IR 4.0, especially in terms of mindset, expertise, and workforce development. The efforts made through the Industry4WRD policy indicate a commitment to overcoming these challenges and harnessing the potential of IR 4.0 for the country's development (Baronio et al, 2017). This is attributed to challenges such as the need for a mindset shift and a lack of expertise in advanced technologies.

Malaysian SMEs have shown interest in embracing digitization, but their enthusiasm is hindered by concerns about information security and data protection (Sommer, 2015). This apprehension leads to reluctance in fully adopting IR 4.0 technologies. In addition, lack of expertise of advanced technologies has become a real challenge for small and medium businesses to acclimate with the changes arising from the digital revolution in the productions and value creation processes (Ghaz,2017). Research on Industrial Revolution 4.0 with connection of SMEs is scant (Muller, Kiel & Voigt, 2018). Conversely, the scholars have discussed the relationship of the Industrial Revolution 4.0 with big organizations and business reasonably (Deloitte Development LLC, 2018). While discussions about the impact of IR 4.0 on larger organizations are more prevalent, there is limited research focusing on the connection between IR 4.0 and SMEs. This research gap highlights the need to explore the specific impacts and challenges faced by SMEs in the context of IR 4.0 adoption.

Literature Review

What is the Industrial Revolution 4.0?

The term Industry 4.0 was initially introduced by the German Government in 2011. It has since become a vital area of research, driven by the use of high-performance computers, advanced internet capabilities, and intelligent machines to reshape business operations. (Ghaz,2017). It has become an important area of research due to this revolution using high-performance computers, powerful internet and intelligent machines for the purpose of transforming business operations (Schumacher, Erol, & Sihn,2016). IR 4.0 encompasses a series of major innovations in digital technologies, including IoT, Big Data, machine learning, and cloud computing. These innovations collectively reshape and optimize the entire value chain of product lifecycles (Ghaz, 2017). IR 4.0 brings up the recent technologies which strengthening to fit in physical objects, human, intelligent machines, production lines and processes to form a novel intelligent, network and improved value chain (Schumacher, Erol, & Sihn,2016). It fetches the digital integration of the suppliers, producers and customers along value chains and business models (Lichtblau, 2015). IR 4.0 focuses on an intelligent world in which smart factories embody the collaboration between digital and physical production networks. The implementation of the Industrial Revolution 4.0 gets the organizations through the great pressures and challenges while increasing the inclusion of machines in the business (Pessl, Romina, & Mayer, 2017).

The trends of the Industrial Revolution 4.0 are already changing the different phases of our lives starting from physical meetings towards virtual ones and so many henceforth. The

automation of manufacturing processes to a new level by introducing customize and flexible mass production developing high technologies (Ghaz, 2017) enhances the productivity and the position of rivalry. According to various experts the growth of intelligent machines will not create issues like man-versus-machine rather the skilled people pertinent to the specific machines will be still needed in future. The management of the organizations and business need to prepare their employees and establish education simulations to work together with the robotics and machines (Abdullah & Salleh, 2017). Value chain and IT-infrastructure are thus used as a base which is not rebuild but retrofitted for an improve efficiency and flexibility (Wank et al, 2016). It can be concluded implementing Industry 4.0 introduces significant challenges and pressures for organizations, especially as they incorporate machines more deeply into their operations. This transformation requires careful planning and adaptation to new technologies.

Success factor for IR 4.0

IR 4.0 can only be successful depending on various factors. Based on Impuls model (Lichtblau, 2015) six factors contribute to of the success of IR 4.0 adoption; employees, strategy and organization, smart factory, smart operations, smart products and data-driven services.

Figure .1 Impuls Model (Lichtblau, 2015)

Employees - Successful implementation of the IR 4.0 requires qualified personnel and skill-sets of the employees (Frische, 2015; Acatech, 2016). The new requirements is re-skilling the employees (Aulbur, 2016 and to develop employees' skills in a targeted manner (Wahl, 2015). Hence, organizations and business need to provide appropriate trainings and development programmes for their employees to enhance and equipped with the skills necessary to work in a technologically advanced environment. (Frische, 2015).

Strategy and Organization - The new technologies plays a crucial role to ensure that the management and process of the organizations and business become efficient in order to adapt with the IR 4.0 (Bermudez & Juarez, 2017). Some aspects of the decision making will be transferred to the intelligent systems (Schlund, 2015). Organizations and business need to creating intelligent networks to help reduces process time, product development time and able for the organizations and business to make faster and flexible decisions (Bermudez & Juarez, 2017). S

Smart Factory - The concept of a smart factory involves the use of technology and data to optimize manufacturing processes (Seghezzi, 2017) and self-configure the tools and material flows dependent on the schedule changes (Burke et al, 2017). Smart factory measures how the organizations and business strive in the future which enable the organizations and business to use an endless data from connected operations and production systems to acquire and familiarize to the new demands of customers, growth into new markets and development of products and services (Seghezzi, 2017). It add data from system wide physical, operation and human assets to drive manufacturing, maintenance, inventory tracking and other activities and hence gives more benefits to the organizations and business especially employees safety and environment sustainability and business performance (Lepukson, 2017).

Smart Operations - Smart operations can guide the production process (Frische, 2015). Smart operations provides routing flexibility that act when an order is received by the organizations and business, instantly there is connected which route need to follow for the well-organized planning and scheduling for the order.). Employees will do less of manual works and more tasks for control and observation of the process in the organizations and business (Aulber, 2016).

Smart Products - Smart products are the products that are inserted with sensors and microchips that allow communication via the Internet of Things (IoT) with each other and human (Roblek, Mesko & Krapes, 2016). It were the solution to take over a machine or process by virtualization with fully independent knowledge (Engelbertink & Woudstra, 2017). Smart products prompting the questions of invasion of privacy, consequently and personal safety (Roblek, Mesko & Krapes, 2016). Smart products should provide the data and have an opportunity of a connection with IT-based system.

Data-Driven Services - The digital transition in the Industrial Revolution 4.0 lead to a major transformation in the organizations and business that will require the organizations and business the considerable investment (Geissbauer & Schrauf, 2015). Example of technology of the Industrial Revolution 4.0 that can be use by the organizations and business is Big Data that consists of four dimensions which are Volume of Data, Variety of Data, Velocity of Generation of New Data and Analysis and Value of Data (Vaidya & Ambad, 2018).

Impacts and Challenges of IR 4.0

Impacts

Industrial Revolution 4.0 brings many impacts to the organizations and business in aspects of its operations. The impacts can be seen from three perspectives: organization, economics and social.

organization - Industrial Revolution 4.0 promises exponential increase in productivity and efficiency (Bakkari & Khatory, 2017). By using data and information collected through the Internet of Things (IoT), IR 4.0 provides advanced analytics possibilities in manufacturing sectors. Manufacturing and business organizations are able to move further than expecting by being able to know accurately when stock levels are low, machinery is about to break down and if there is a change with the demands. Production cycles can then be matched with the real time information coming in (Agamuthu, 2017). Automation will increase the normalization in process and procedures and then reduce inconsistency and faults in products (Abdullah & Salleh, 2017). At the same time IR 4.0 is cost effectiveness which enable the organization to provide supply chain operations with shareable data on supply levels, inventory readings and transportation simulations to avoid blockages and troubleshooting with the help of Big Data (Lichtblau, 2015). Industrial Revolution 4.0 is also increased productivity of the organizations and business. Integration of smart materials and equipment that can detect and fix itself help streamline processes and make more useful production (Maindron, 2015). As a whole IR 4.0 will improve demand capacity management, improving efficiency and lowering the operating costs of manufacturing companies.

Economics - IR 4.0 gives benefits to economics in term of maximized revenue on the labour markets and the demands for flexibility (Aulber, 2016). The countries that are best adjusted to relocation labour resources from old contracting sectors to new and growing ones will have advantages in terms of lower unemployment rates and higher potential growth (Agca & Gibson, 2016). For a rural area, the Industrial Revolution 4.0 also gives an impacts to the agricultural raw materials and replacement of transportations systems (Abdullah & Salleh, 2017).

Social – IR 4.0 can offered new and highly paid opportunities for employees (Nagy, 2018), hence may increase incomes for the employees. In America for example, IR 4.0 companies can offer good salaries and decent working conditions for a woman (Maindron, 2015). At the same time customers also has become more outcome oriented to signify a new business model (Burke et al, 2017). Organizations and business likely to change the business models for their innovation and add flexible value chains to maximize the awareness to the change of consumer behaviours. To deal with high-quality products and services, smart production systems need to collaborate with the smart factory (Morrar, Arman & Mousa, 2017).

Challenges

Despite the impacts of IR 4.0, there are few challenges of IR 4.0 that the business organization should prepare. The summary of some challenges can be seen from two perspectives: employee and organization as shown in Table 1.

Table 1:
Summary of challenges of IR 4.0

Challenges	Authors (Year)	Descriptions
Employee knowledge and understanding	Ivroth (2016)	the workforce needs to get technical skills aligned with the new technologies.
	Wank et al, (2016).	Enterprises need to develop suitable programmes for their employees to enhance their skills align with the requirement of the Industrial Revolution 4.0
	Viharos & Soos (2017).	Organizations and business should start play preparatory role to make sure that their employees can trust and accept the ideas behind the Industrial Revolution 4.0
	Zakri (2017).	the Industrial Revolution 4.0 which includes the areas of hiring pertinent people with skills of advanced technology and according to new types of demands. This may threaten the current market position of the many business
	Vaidya & Ambad (2018).	If the employees in the organizations and business feel anxiety towards the Industrial Revolution 4.0, it will prevent the implementation process of the Industrial Revolution 4.0 in the organizations and business.
Organizational	Schumacher, Erol, & Sihn (2016)	the Industrial Revolution 4.0 also exposed the organizations and business to the new competitors that offer smart and connected product solutions.
	Bergstrom & Venema (2018).	Industrial Revolution 4.0 creates wholly new type of industries and uncover recognized organizations and business to a new competitive and challenges.
	Ghaz (2017).	the need of high degree of reliability and stability for successful cyber-physical communications.
	Schlotzer (2015);	Maintaining the uprightness of the production process with less human oversight

	Mubarak, M. F., & Yusoff, W. F. W, (2019).	Loss of high-paying human jobs. Avoiding and fixing the technical problems also one of the challenges of the Industrial Revolution 4.0
	Bermudez & Juarez (2017).	Big Data Analytics issues as operations of the organizations and business will be driven by data produced by sensors insides the machines and robots, the organizations and business have to find out how to gather data suitably. Organizations and business will struggle with the collection of data.

Many governments have realized the importance of exploring and exploitation of IR 4.0 for development of economies and they are putting financial and non-financial efforts to inculcate the whereabouts and benefits of IR 4.0 (Geissbauer & Vedso, 2015; Mubarak M.F., et al., 2019). However, many SMEs are under-prepared and muddled about this process (Maindron,2015). This very thing is becoming the prime barrier in SMEs competitiveness and internationalization (Park, 2016).

Research Methodology

The study adopted qualitative approach which enables researcher to read and engage with information critically, and also enhance the crux from the large body of information towards specific and required (Mason,2012). To achieve the objective of the study data were collected using open ended interviews. Before the interviews are being conducted, the interview guided questions were developed. The instrument was verified by the four relevant experts. Once completed the interview questions were updated, finalized and preceded according to the experts' opinions.

The sampling was done based on purposive sampling focus on characteristics of the population that are best enable for researchers to answer the research questions (Gleen, 2015). As all of the respondents (20 manufacturing SMEs owners in Johor) they had sufficient knowledge and experiences to answer the questions. They are considered fulfil the characteristics for this study. Johor is considered as one the top manufacturing state in Malaysia and therefore the respondents chosen in this study are considered having similar characteristics with other SMEs in Malaysia. The interviews were done through face-to-face contact and followed up by an email of the questions to be answered.

The data from the interview have been organized using thematic analysis based on pre-determined variables from the literature review. The method allows the researcher to look at the responses and answers to each objective and specific question individually, to make it easier to pick out the ideas and concept (Gibson, 2015). The responses and answers from the respondents are organize into codes or categories.

Results and Discussions

Based on thematic analysis it is revealed that the SMEs of Malaysia are aware regarding the impacts and challenges in adopting IR 4.0. In the context of impacts of IR 4.0 adoption most respondents pointed IR 4.0 give both positive and negative impacts to the SMEs in term of the whole business organization and operation, economics and social. While the main challenges would be from the perspectives of organization and employees themselves. Of

the 20 respondents, 17 of them stated that opinion. The summary of impacts and challenges of adoption of 4.0 in in Table 1 and the breakdown of each impact is shown in Figure 1 and 2.

Table 1:
Summary Impacts and challenges adopting IR 4.0

Respondent	Impacts			Challenges	
	Organizational	Economic	Social	Organizational	Employees
R1	√	√	√	√	√
R2	√				√
R3	√	√			
R4	√			√	√
R5	√			√	√
R6	√	√	√	√	√
R7			√		
R8	√			√	
R9	√			√	
R10		√	√		
R11	√		√	√	√
R12	√			√	√
R13	√	√	√	√	√
R14	√	√	√		
R15	√			√	√
R16	√		√	√	√
R17					
R18	√			√	√
R19	√			√	
R20	√			√	√
Total	17	6	8	14	13

Impact of IR 4.0 Adoption

Figure 1 shows the overall results for the impacts of IP 4.0 adoption. It is found that majority of the SMEs' manufacturing owners had acknowledged the positive impacts of IR 4.0. especially in term of making business process faster and easy, increase productivity and quality. These positive impacts indirectly contribute to economic in term in more local products can enter to global market and increase country's income. At the same time IR 4.0 adoption able to reduce foreign workers of the country.

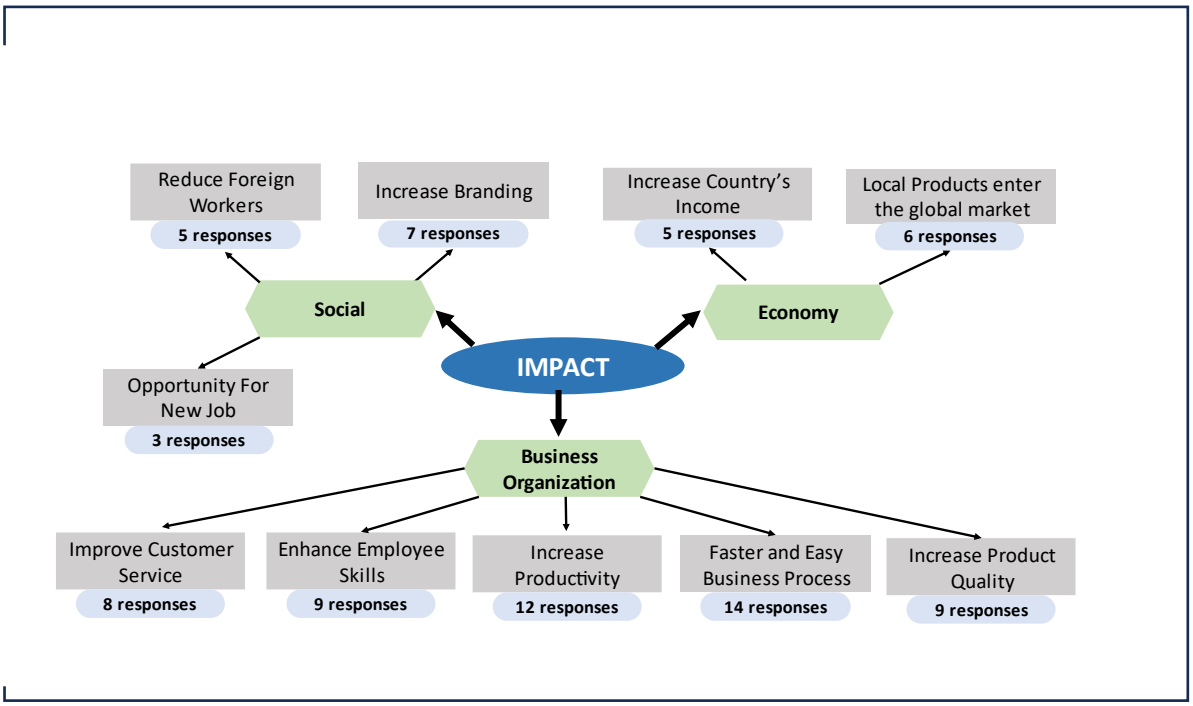

Figure 1: Impacts of IR 4.0 Adoption

From business organization perspective based on literature as adoption of IR 4.0 will lead the business using data and information collected through the Internet of Things (IoT. The IoT allows businesses to gather vast amounts of real-time data from various sources in the manufacturing process. This data can be analyzed to gain insights into operational patterns, product performance, and potential areas for improvement. Organizations can make informed decisions based on data-driven insights, enhancing overall operational efficiency. (Bakkari & Khatory, 2017). Specifically, the SMEs in manufacturing business are able to control supply chain operations, inventory readings and transportation simulations to avoid blockages and troubleshooting (Lichtblau, 2015; (Agamuthu, 2017). These will reduce inconsistency and faults in products (Abdullah & Salleh, 2017); help streamline processes and make more useful production (Maindron, 2015) and ultimately lowering the operating costs (Ghaz, 2017). For example technology of the IR 4.0 that can be use by manufacturing SMEs is Big Data that consists of four dimensions; Volume of Data, Variety of Data, Velocity of Generation of New Data and Analysis and Value of Data (Vaidya & Ambad, 2018).

In a bigger impacts IR 4.0 adoption high possibility for the country to maximize revenue on the labour markets (Aulber, 2016) by offering new and highly paid opportunities for employees (Nagy, 2018). However, the implementation of the IR 4.0 requires qualified personnel and skill-sets of the employees (Frische, 2015; Acatech, 2016). Hence, SMEs need to provide appropriate skills development programmes on technologically advanced environment. (Frische, 2015). At the same time IR 4.0 can, customers also has become more outcome oriented (Burke et al, 2017). In a long-term as IR 4.0 plays a crucial role to ensure that sustainability of business especially the manufacturing industry, the SMEs likely need to change the business models (Bermudez & Juarez, 2017). Hence, SMEs need to analyse the need for implementation of IR 4.0 (Cordes & Stacey, 2017).

Challenges of IR 4.0 Adoption

Although many positive impacts can be seen through the IR 4.0 adoption, SMEs also face few challenges to business organizations. As in Figure 2 the manufacturing SMEs owners in Malaysia said that cost would be the main challenges in adoption as the need to invest in acquiring new technology. At the same time as majority of their employee lack of knowledge and skills in IR 4.0 they need to train employees to handle the technology.

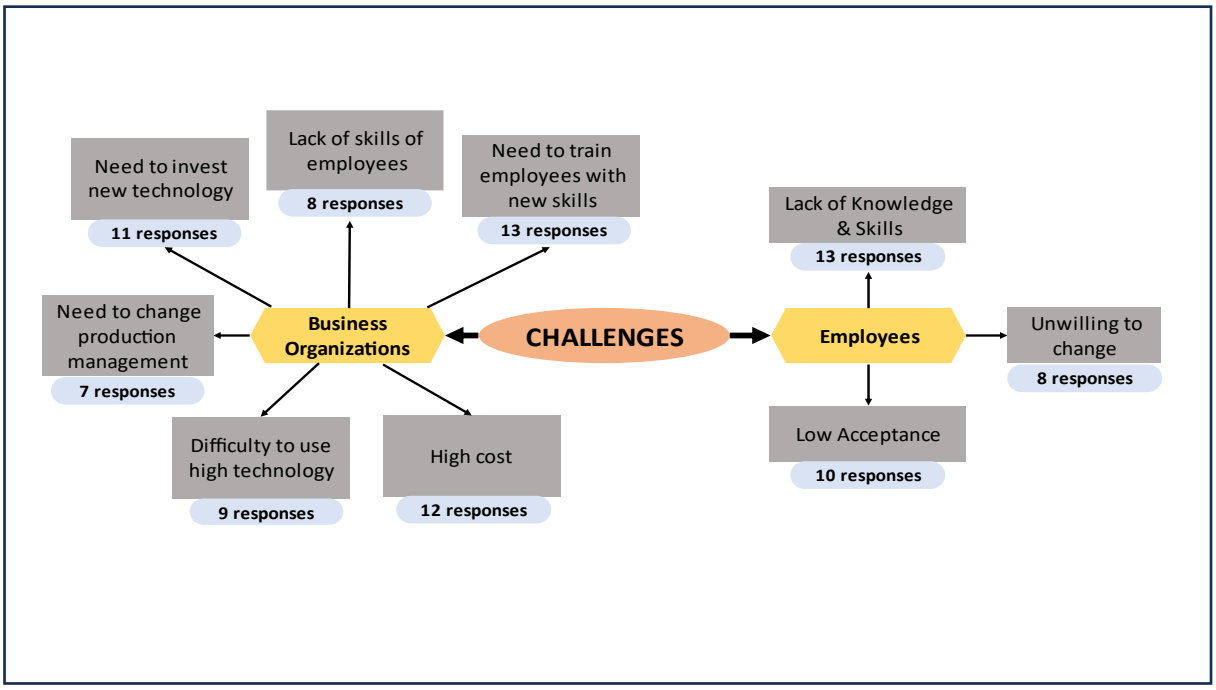

Figure 2: Challenges of IR 4.0 Adoption among SMEs in Malaysia

The introduction of the Industrial Revolution 4.0 should be more active among all the organizations and business either big organizations and business or small organizations and business (Arl, 2017). However, many SMEs think IR 4.0 adoption become the challenge to them especially in the perspective of company and the employees themselves. Based on Figure 2 these challenges will require to a major transformation of the SMEs and considerable investment (Geissbauer & Schrauf, 2015). If the technologies do not reach the standards of the Industrial Revolution 4.0, then its implementation will not become success (Baronio et al, 2017). For example the adoption of smart factory in the manufacturing business can drive manufacturing, maintenance, inventory tracking and other activities (Lepukson, 2017).

At the same time another major challenges employees may not yet accepting the technology and unwilling to change. This in line with Vaidya and Ambad (2018) who argued employee should not felt any anxiety towards IR 4.0. For employee qualifications and acceptance, SMEs need to hire employees who have a skills that qualified with the new technologies that are introduce by the IR 4.0 (Ivroth (2016) and develop suitable programme on IR 4.0 that can enhance employee knowledge and skills (Wank et al.,(2016).

Conclusion

In conclusion while the manufacturing SMEs in Malaysia are aware of the potential benefits of Industry 4.0 and its positive impacts on both their businesses and the country, they are not fully prepared to embrace the concepts and technologies associated with it. The main obstacle appears to be financial challenges, which hinder their ability to effectively adopt Industry 4.0 practices. Financial and non-financial support from the government is needed to enable SMEs to successfully integrate Industry 4.0 practices into their operations, which in turn could contribute to the growth and development of the manufacturing industry in Malaysia.

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