

Semi- Structured Interview of Industry 4.0 for the SMEs in the Malaysian Construction Industry

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Abstract: Industry 4.0 (IR 4.0) is becoming a trend in various sectors despite being originated from the manufacturing industry. This concept has even grasped the attention of the construction sector due to its various benefits such as increased in product quality, productivity, and cost savings. In order to adopt this concept for the construction industry, focuses should be placed upon the small and medium-sized enterprises (SMEs) since they play a major part in influencing the economy. This paper aims to examine the challenges, enablers of IR 4.0, investigate the readiness and identify the ways to improve the implementation of IR 4.0 for the SMEs in the Malaysian construction industry. This study employed a semi-structured interview amongst twenty (20) industrial construction players around the Klang Valley. The collected data was then analysed and the results showed that they agreed that the main challenges in adopting IR 4.0 concept for the construction SMEs were lack of financial resources, ineffective process change strategy and low experiences in utilizing skilled applications and technologies. The interviewees believed that the important enablers for IR 4.0 in the construction industry were Building Information Modelling (BIM), cloud technology, and Industrialised Building System (IBS). BIM is also becoming a growing trend in the construction industry. The interviewees mentioned that the current readiness of the IR 4.0 concept for the construction SMEs is still below par yet there is still potential to be improved especially in terms of the organisations management, awareness, and implementation level. Government and its agencies need to play the biggest roles as the driving force in ensuring advanced technologies are successfully implemented in the construction industry. The results from this research will be used to produce a robust framework to hasten the adoption of IR 4.0 for the construction industry SMEs.

Keywords: Construction industry, construction SMEs, Industry 4.0, IR 4.0

1. Introduction

The concept of Industry 4.0 (IR 4.0) is becoming a huge booming trend in several industries nowadays. This concept originated from Germany in which its sole purpose was to enhance its countries economic performance through the digitization of their manufacturing sector (Roblek et al., 2016; Vogel-Heuser & Hess, 2016). According to Kolberg et al. (2016), IR 4.0 is defined as “The vision of smart components and machines which are integrated into a common digital network based on the well-proven internet standards”. It can also be considered as the emergent of cyber-physical systems (CPS) involving entirely new capabilities between people and machines (Davis, 2016).

In Malaysia, a national policy known as ‘The National 4IR Policy’ was created as a proof of the government’s commitment towards realising the digital revolution. The aim of it is to transform the socioeconomic development of the country through ethical use of IR 4.0 technologies. It helps in providing the principles and strategic direction in formulating the policies and action plans that can optimise resource allocation and implement ideal coordination in matters related to emerging technologies (Economic Planning Unit (EPU), 2021).

Various industries have demonstrated drastic development through the ongoing introduction of innovative technologies yet despite that, the construction industry is still very hesitant in incorporating it to their common practices (Alaloul et al., 2020). A survey that was conducted by Roland Berger back in 2016, determined that about 93% of construction stakeholders are on the same page that working processes in construction can be greatly affected by the concept of digitization yet only a small number of construction firms are maximizing the full potential of digital planning tools which raises a concern for the construction industry in the pathway of achieving digital transformation in the future.

The Malaysian construction industry has continued to play a significant role in the economic growth of the country, as well as facilitating the development of socioeconomics of the society at large. The need for a high-quality physical infrastructure and wide access to affordable housing has fostered the adoption of new technologies and new construction methods (Construction Industry Development Board (CIDB), 2021). The positive outlook towards the state-of-the-art technological adoption in the construction industry highlights the need for an ideal framework on how to properly introduce it into the sector.

Around the world, small and medium sized enterprises (SMEs) is considered as one of the most significant forces for the development of a country’s economy. SMEs are acknowledged as the vital factor to stimulate innovation, increasing the economic growth, job opportunities and reducing poverty (Rotar et al., 2019). According to the

CIDB, in the Malaysian construction industry, more than 90% of registered construction companies are SMEs (CIDB, 2011). Thus, much focus should be placed first upon the SMEs in regards to formulating the framework for the IR 4.0 adoption for the construction industry.

The objectives of this research were to determine the challenges faced by SMEs in adopting IR 4.0 in the Malaysian construction industry, propose the enablers of IR 4.0 for the Malaysian construction industry, investigate the readiness of SMEs in the Malaysian construction industry, and identify the methods to successfully implement IR 4.0 for the construction SMEs.

2. Industry 4.0 in the construction industry

A country's economic performance is greatly influenced through the contribution of several sectors such as the construction industry. A report that was made by the World Economic Forum & The Boston Consulting Group (2018) highlighted that the world gross domestic product (GDP) for the construction industry currently stands at around 6% and is expected to increase up to 14.7% by the year 2030 (Global Construction Perspectives & Oxford Economics, 2015). The construction industry in the European Union (EU) is responsible in providing around 18 million jobs to the people with the help from various stakeholders and companies and is considered as an important sector for the economy (European Commission, 2016). In the report posted by the Department of Statistics Malaysia (DOSM), the value of construction work done in the third quarter of 2019 contracted around 0.6% year-on-year basis, generating up to RM36.1 billion as compared to the second quarter which amounted up to RM35.9 billion (Department of Statistics Malaysia (DOSM), 2019).

Despite the economic success, the perception of the construction industry is still quite conservative, highly reliant on low technology, having poor quality image and low performance (Al-Qutaifi et al., 2018). The big reason on why it is challenging for the industry to adapt new technologies is due to the unique and complex nature of the construction sector itself. Construction companies hesitated to adopt new technologies because of the investments and uncertainty concerning the resulting benefits that lies behind it (Davies et al., 2014).

Most of the construction industry companies are made up of SMEs and because of this, it hinders their capabilities to invest in advanced technologies. To overcome this issue, most SMEs will have to rely on the assistance from governing bodies and authorities through partnership and funding programs to help with the IR 4.0 implementation (Alaloul et al., 2020).

3. Malaysian construction industry smes

SMEs are an efficient engine of growth since they contributed a lot towards job opportunities and economic development (Arthur-Aidoo et al., 2015). The definition of SMEs can be categorized through various aspects such as capital assets, labour skills, turnover level, method of production and legal status. Several literatures regarding SMEs usually defines them based on two characteristics which are the number of employees and or the firm's fixed assets which is in line with their function. A good thing to take note as well is that there is no accepted standard definition of SMEs and they are highly dependent upon the industries and countries (Matt & Rauch, 2020).

In Malaysia, construction SMEs can be defined as an enterprise that has a tendering capacity less than RM 5 million and a paid-up capital which is less than RM 250,000 according to Construction Industry Development Board (CIDB) (Kamal & Flanagan, 2014). The paid up capital and tendering capacity are used by CIDB in categorizing the grade of contractors from G1 until G7. Therefore, it can be said that for SMEs, it can be graded from G1 until G5 grade of contractors.

4. Methodology

A semi-structured interview was conducted for this research in order to complement the findings obtained from an earlier questionnaire survey involving a similar topic (Bin Tayib et al., 2022). Upon completion of the survey, a decision was made as to the most appropriate approach for conducting the interviews for this research. The interview questions were properly designed and were put through a pre-test process to ensure that they were suitable for gathering as much valuable data as possible on the subject being studied. The literature review and the findings from the survey, on which the questions for the interviews will be based upon were meant to provide more in-depth understanding, insight, and information before proceeding further into the next step of the framework development.

The data collected from this semi-structured interview was then transcribed for further analysis and interpretation. The information gathered from the semi-structured interviews formed the basis for the next step of the research later, which is the Modified Delphi survey. Figure 1 outlines the execution of the interview process in this research.

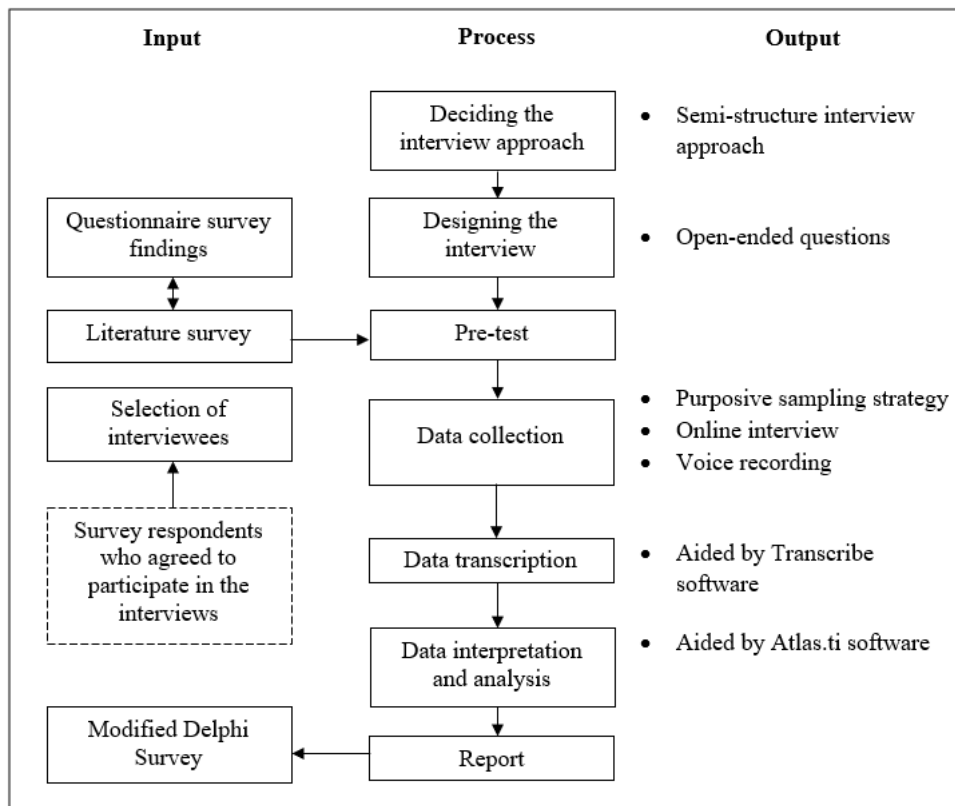


Figure 1: Interview Execution Process

The built up of the questions for this semi-structured interview was based on an earlier study (Bin Tayib et al., 2022) which was distributed amongst 150 construction SMEs around the Klang Valley regarding the implementation of IR 4.0 for the SMEs in the construction sector. Table 1 displayed the questions that will be used during the semi-structured interview.

Table 1: Interview Questions

Themes	Questions
Challenges faced by SMEs in the Malaysian construction industry in adopting IR 4.0.	<ol style="list-style-type: none"> 1) Do you agree on the list of five (5) top challenges faces by construction SMEs in adopting IR 4.0 as obtained from the questionnaire survey? Please elaborate in detail each of those challenges. 2) Based on your experience of being in the construction industry, what do you think are the other challenges that could slow down the adoption of IR 4.0 in the industry?
Enablers of IR 4.0 in the Malaysian construction industry.	<ol style="list-style-type: none"> 1) Do you agree on the list of five (5) common enablers of IR 4.0 in the Malaysian construction industry as obtained from the questionnaire survey? Please elaborate in detail each of the enablers. 2) Based on your experience of being in the construction industry, what do you think are the other enablers of IR 4.0 in the industry?
Readiness of SMEs in the Malaysian construction industry in adopting IR 4.0.	<ol style="list-style-type: none"> 1) Do you agree on the list of five (5) top readiness of construction SMEs in adopting IR 4.0 in the Malaysian construction industry as obtained from the questionnaire survey? Please elaborate in detail each of the factors.
Ways in improving the implementation of IR 4.0 for the SMEs in Malaysian construction industry.	<ol style="list-style-type: none"> 1) What would be the important elements that can improve the success of implementing IR 4.0 for the construction SMEs?

Purposive sampling strategy was employed to select the participants for the semi-structured interview. As the name implies, purposive sampling is 'confined to specific types of people who can provide the desired information, either because they are the only ones who have it, or conform to some criteria set by the researcher (Sekaran & Bougie, 2009). As such, since this research is about the nature of IR 4.0, the ideal persons to provide information are those who have confronts, possessed a general idea around IR 4.0 in construction or utilize technological development concept in their businesses. The participants will be the consultants and G1 until G5 contractors which were deemed as the SMEs for construction.

Prior to the execution of the interview, the potential participants, i.e., the questionnaire survey respondents who demonstrated their willingness to participate, were contacted through email and phone to set the date and location for the interview. A letter of invitation was sent to the potential participants to choose the date, time and place deemed appropriate for the interview. To eliminate the problem of low participation, the interview question sheet was provided only upon request. However, the cover letter contained a detailed explanation of the interview, including the objectives and topic to be discussed, to allow the participants to be prepared.

Also, the participants were selected based on their current designations, relevant experience, and availability during the scheduled interview period. As obtaining in-depth information and time constraints were the main concerns in this research, the interview was limited to only experienced practitioners with a minimum of ten (10) years in the construction industry and experience in dealing with IR 4.0. In total, twenty (20) out of the forty-one (41) respondents confirmed their participation. The details of the interviewees' profiles are illustrated in Table 2

Table 2: Interviewee Profiles

	ID	Designation	Years of experiences
1.	A1	Engineer	18
2.	A2	Engineer	17
3.	A3	Quantity Surveyor	10
4.	A4	Architect	22
5.	A5	Quantity Surveyor	25
6.	A6	Engineer	18
7.	A7	Project Manager	12
8.	A8	Engineer	22
9.	A9	Engineer	25
10.	A10	Architect	29
11.	A11	Engineer	30
12.	A12	Project Manager	28
13.	A13	Engineer	27
14.	A14	Architect	23
15.	A15	Architect	22
16.	A16	Engineer	22
17.	A17	Quantity Surveyor	26
18.	A18	Architect	22
19.	A19	Project Manager	30
20.	A20	Architect	26

As depicted in Tables 2, the 20 interviewees were spread evenly across the two groups of industry participants, consultants and the G1 until G5 contractors. In terms of experience in the industry, all the interviewees had been in the industry for more than ten (10) years. The practical experience of the interviewees suggest that the information, ideas, and insight provided by them were highly valuable for this research.

5. Result and analysis

Twenty (20) interviews lasting between 45-90 minutes per session were conducted. Hagaman & Wutich (2016) asserted that there are no pre-set rules on the number of interviews but numbers ranging from twenty (20) to forty (40) is needed to reach data saturation. The first section of the interview question was designed to ask interviewees about the challenges faced by the construction SMEs in the Malaysian construction industry in adopting IR 4.0. The purpose of this question was to further investigate the industry practitioner's opinion in the issues that may be found when trying to implement IR 4.0. The interviewees were informed of the survey results that listed the following as the top five (5) challenges faces by construction SMEs; (1) shortage of financial resources; (2) absence of an ideal process change strategy; (3) not used to utilizing highly skilled applications and technologies; (4) concerns of cyber security, the crimes of hacking and risk assessment, and (5) lack of a skilled workforce. All the interviewees agreed with these five challenges and were then subsequently asked to elaborate on these issues based on their working experiences. They were also asked on what other challenges that they think that could be faced by SMEs in adopting IR 4.0.

The second part of the interview question was designed to ask interviewees about the enablers of IR 4.0 for the SMEs in the Malaysian construction environment. The purpose of this question was to further investigate the industry practitioner's opinion in the technologies that may be found when trying to implement IR 4.0. The interviewees were informed of the survey results that listed the following as the five (5) common enablers of IR 4.0 by the construction SMEs; (1) Building Information Modelling (BIM); (2) modularization/prefabrication; (3) Augmented/Virtual/Mixed Reality (AR/VR/MR); (4) Cyber-Physical systems (CPS) and (5) Cloud Computing. The interviewees generally agreed with these five enablers and were also asked on what are the other enablers in regards to IR 4.0 in the construction industry.

The third part of the interview question was created to ask interviewees about the readiness of the SMEs in adopting IR 4.0 in the Malaysian construction industry environment. The earlier survey results listed the following as the top five (5) important criteria of the readiness of the construction SMEs in the Malaysian construction industry; (1) modelling and simulation such as AutoCAD and BIM; (2) accessibility to internet; (3) modularization or prefabrication; (4) skill development and (5) openness of employees in learning new technology.

And the final part of the interview question was designed to ask interviewees about the important elements that can improve the success of implementing IR 4.0 and the ways to improve the implementation of IR 4.0 for the SMEs in the Malaysian construction industry. It listed the following as the top five methods (5); (1) regulatory framework and adoption of IR 4.0 in the company; (2) provide roadmaps for the IR 4.0 adoption; (3) enhancement of workforce's knowledge and re-skill, up-skill training; (4) formulate a national policy of IR 4.0 that focuses on the construction industry; (5) have a clear written change strategy. The data from the semi-structured interview questions were transcribed using Transcribe software and analysed using the Atlas.ti software. The analysed data was highlighted and tabulated in Table 3 below.

Table 3: Interview Results

Interviewees	Comments
A1	<ul style="list-style-type: none"> • "Situation would become more complex when the adoption of technology such as IBS in the construction business requires high capital intensive. Due to this, small contractors who has no existing financial backup are not able to set up their own manufacturing plants as it involves very high capital investment."
A2	<ul style="list-style-type: none"> • "The traditional methods of doing things in construction are slowly, slowly becoming obsolete because there is simply a technology becoming cheaper and cheaper. Cost is one of the most important factors to be considered all around."
A3	<ul style="list-style-type: none"> • "Making big changes to existing business processes is often a long journey and not easy, particularly when making necessary upheavals to business components that have been in place for many years."
A4	<ul style="list-style-type: none"> • "I think the pressure on the management, especially on the top management of construction companies, will certainly increase over time." • "Human resources face extreme challenges in the construction industry with more and more labor and a massive skill shortage. Furthermore, the sector has become less popular and less attractive to younger generations. Lack of career paths, gender problems and generational problems inhibit the industry's attractiveness. These factors can lead an entire generation to never even entering the industry."
A5	<ul style="list-style-type: none"> • "I think the implementation is the main issue. The process is not easy as well, but implementation is the toughest thing."
A6	<ul style="list-style-type: none"> • "Companies operating in the modern business landscape are increasingly finding themselves managing more than just employees, customers, and products. Modern businesses must manage change. To do so, they need to change their management strategies. Yet, as with any drastic upheaval in an organization,

Interviewees	Comments
	<p>formulating a structured change management plan can be difficult. Employees may be reluctant to “try new things.” It can be tough to secure a budget as decision makers may not see the need to update processes which seem like they are working.”</p> <ul style="list-style-type: none"> • “90% of construction businesses at least are already paying for Word, Excel, and PowerPoint, and then you just teach them how to work on the same document at the same time, which is BIM.”
A7	<ul style="list-style-type: none"> • “AR has great potential to be adopted in the construction industry, provided that the obstacles hindering the adoption are resolved.”
A8	<ul style="list-style-type: none"> • “Several SMEs are facing a lacking workforce or in if they have an ageing workforce and we see that the constructions it is not attractive for younger generations.” • “Not just in the younger people are more attracted by anything that is digital electronics, and if the sector is completely lacking in that field is not just there, not sexy for them so that they go to other sectors.” • “I think that then they will invest in some of their work for security or must be trained to do this. I think this is very important. If they do not, if they are not convinced that they will have a benefit from new technology, they will just continue business as usual.”
A9	<ul style="list-style-type: none"> • “You know your competitive advantage should not be the data about the buildings you are constructing.”
A10	<ul style="list-style-type: none"> • “Subscription, and it is ridiculously expensive and less prohibitive when it comes to applying these digital technologies for the SMEs.”
A11	<ul style="list-style-type: none"> • “Many small contractors especially Bumiputera contractors are unwilling to adopt IBS in their construction business. They prefer to carry on using the traditional method of construction. The main reason for this is because of they are too familiar and comfortable with the traditional system and for them the technology suits well with small scale projects. Thus, they feel that there is no need to switch to IBS.” • “A high adoption rate for AR, VR and other technologies should be the aim of Malaysian construction businesses going into future to prepare themselves to compete in the global market.” • “They cannot say because they do not understand what is possible, so it is hard for them to see the big picture.”
A12	<ul style="list-style-type: none"> • “There is no organization that can avoid change. Change raises concerns because people fear economic losses, inconvenience, uncertainty, and disconnect from common social patterns. Almost every change in structure, technology, people, or strategy has the potential to disrupt patterns of interaction that are already comfortable.”
A13	<ul style="list-style-type: none"> • “SMEs construction companies need to have capital and knowledge in IBS, position themselves as a total IBS solution provider to clients, target projects with large volumes of building components, employ a small number of fulltime employees as well as to have inhouse capability and to outsource some facilities in the business operation.”
A14	<ul style="list-style-type: none"> • “Advanced technologies will be able to automate routine physical and interpersonal tasks, leaving humans to focus on more complex and novel tasks that require problem-solving abilities.”
A15	<ul style="list-style-type: none"> • “The construction industry is seen as an industry that does not really have career paths. That is partly because there are not always many kinds of joins to upskill people more, enable people to move within the industry to different disciplines.”
A16	<ul style="list-style-type: none"> • “Without any technology, just by organizing the work smartly, you can save 50% of all the time and using technology will boost it even further.”
A17	<ul style="list-style-type: none"> • “Also, for the consultants, things have become more complicated, and they have got a problem with the skill set. That thing risk now in producing these construction details, they end up getting things wrong, and people see them, but at the same time there is lots of good money in that.”
A18	<ul style="list-style-type: none"> • “A cloud based real-time project performance monitoring and reporting system will allow all stakeholders to be part of every stage of the project delivery process. Cloud adoption will allow project progress to be monitored in an open manner. The use of cloud platform to monitor project progresses will eliminate delays and block leakages arising from inaccessible information.” • “Once you can separate them and holistically, look at the building and then you are able to optimize it and change things and understand exactly the implications. So, it is about looking at the product and building a better product.”
A20	<ul style="list-style-type: none"> • “Construction, as an industry, is still learning that the industry needs to become more social. Construction has growing up to do in terms of the way that they treat their people, and I think that we are going to see a shortage of tech strong workforce because they are being pulled out by the technology companies.” • “Labor rates will rise because we must pay people more in order to get them interested. So, then construction costs of construction will go up because there is a direct relationship with the labor cost.”

6. Discussion

The discussion of the IR 4.0 concept amongst the construction SMEs received various impression from the interviewees based from the result in Table 3 above. For example, interviewee A6 mentioned that the introduction of the concept towards the industry is very good but there is a concern on how the execution will

be especially when it focuses towards the SMEs. The issue will arise due to the concern of limited financial ability of the organizations. Most of the interviewees acknowledged that shortage of financial resources is the most complicated and difficult challenges in implementing IR 4.0 for the SMEs. This is because a lot of the idea revolving around IR 4.0 requires the existence of advanced technologies and development that can enhance and improve the productivity of the construction businesses (Maskuriy et al., 2019). According to interviewee A11, the biggest challenge presented is that each SMEs was limited by a set number of resources and this slows down any technological adoption especially for new starting businesses. Cost is a significant barrier in the adoption of IT solutions by construction companies, because of its low-profit margin (Kumar et al., 2019) and most construction companies are seeking new ways to drive down infrastructure and operational costs (Bello et al., 2021).

The ability to address and adapt to change within an organization is becoming a critical element of survival for many modern businesses in the current digital transformation landscape. Management plays a huge role in the success of introducing new concept or methodology within the organization context (Agostini & Filippini, 2019). The sizes of the company can also affect how the adoption is going to be executed since the nature of the firms varies between small/medium and large sized enterprises (Schröder, 2016). Failure in digital transformation projects almost always comes down to a lack of preparation and strategy (Brunetti et al., 2020). Interviewee A8 highlighted that while preparing the workforce for IR 4.0, it is important to address skills shortages and lack of preparation for the workplace due to the difficulties with finding, training, and re-skilling staff. The accumulated feedbacks given by the interviewees in regards to the current work landscape, accentuate the current readiness of the SMEs in adopting the IR 4.0 concept and it showed that there is still much efforts needed to be done in order to make it a reality.

The physical and digital systems that exist nowadays were found to be very efficient however it comes with the risk of a cyber-attack (Li & Liu, 2021). When numerous machines and devices are connected to single or multiple networks, vulnerabilities in any one of those pieces of equipment could make the system vulnerable. Companies are not fully prepared to deal with these security threats, with many relying on their technology and solution providers to scope out vulnerabilities as commented by interviewee A18.

All interviewees acknowledged that BIM is a major propeller for the concept of IR 4.0 in the construction industry. Application of BIM is essential to drive the industry towards sustainable construction which underlines long term affordability, quality, and efficiency (Takim et al., 2013). Other emerging construction technique such as Industrialised Building System (IBS) was also pointed out throughout interview. IBS can improve quality, productivity, and efficiency of the construction project with the use of the factory-made product (Kamar et al., 2012). Yet the increase in IBS adoption in the Malaysian construction industry is causing concerns for companies especially contractors as it is potentially causing adverse effects on their business opportunities. The use of IBS would reduce many on-site activities and the number of on-site trades such as carpentry work, bricklaying, bar bending and manual on-site jobs (Theong et al., 2018).

More than half of the interviewees agreed that government and its agencies play the biggest roles in driving the IR 4.0 enablers in the construction industry. An initiative was introduced by the Malaysian Government in the Construction Industry Transformation Plan (CITP) whereby construction companies are urged to adopt innovative technologies in order to maintain their competitiveness in the market share and enhance the construction productivity. It is unquestionable that SMEs' companies have limited resources and thus, several incentives could be given to them by the government to help release them from the financial burden as recommended by interviewee A16. Interviewee A20 suggested that financial aids such as tax reduction and reduce or exempted from CIDB levy for BIM implementers were sought. Other forms of incentives (i.e., recognition to SME's company's implementing latest technologies; yearly rewards; and special awards) could motivate SMEs to be committed in adopting IR 4.0 technologies for their projects. All these rewards, awards, and certifications would give merit to SMEs contractors and will assist them to be further recognized by the government and other professional bodies. Overall, there is a clear, active, and yet unfinished discussion about IR 4.0 in the current landscape of the construction industry.

7. Conclusion

The implementation of IR 4.0 for the construction industry is becoming a huge interest around the sector as of this moment. Nevertheless, much work is needed in order to ensure that the implementation can be realised especially for the SMEs. Based from this research, a couple of things that needs to be pointed out is that challenges need to be addressed and dealt with. The lack of financial backup, ineffective process changes

strategy and lack of experiences in utilizing skilled applications and technologies are the main challenges in the adoption of IR 4.0 for the SMEs. Absence of a process change strategy can slow down the implementation efforts and not only that, utilization of new innovative technologies requires comprehensive training and time.

On a positive note, technologies such as BIM, cloud technology and IBS is becoming a growing trend in the construction industry yet the adoption and practice amongst the SMEs are still quite low. In regards to security, there is a need to implement a robust security system to protect organizations against hacking and unintentional data breaches in preparing for the implementation of IR 4.0. The current readiness of the IR 4.0 concept for the construction SMEs is still below par yet there is still potential to be improved especially in terms of the organisations management, awareness, and implementation level.

Government and its agencies such as CIDB play the biggest roles as the driving force in ensuring advanced technologies are successfully implemented in the construction industry. Having a guideline, roadmap or a policy that focuses on the construction sector for IR 4.0 adoption is an important step towards the adoption of IR 4.0 for the construction industry. The results from this research shall be used in producing a framework for the adoption of IR 4.0 for the construction SMEs in the near future.

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