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Improving Fourth Industrial Revolution (IR 4.0) Implementation among Skilled Workers in the Construction Industry

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Abstract: As the COVID-19 pandemic, the construction industry's operating process have changed, which accelerates the construction industry to move toward Industrial Revolution 4.0. Furthermore, skills that have been thought would endure over time could quickly become obsolete among skilled workers, and upskilling the skilled workers will face formidable challenges arising from the influx of new technologies. Therefore, this research was undertaken to identify challenges, influencing factor, and steps to improve the IR 4.0 implementation among skilled workers in the construction industry. To accomplish the objectives, the study was carried out with the quantitative approach by using questionnaire as the instrument to collect the primary data. There were 248 respondents among G7 contractors selected at Johor state for this research and 145 respondents have been successfully collected. Statistical Package for the Social Science (SPSS) software was utilised to analyse the collected data in descriptive methods to determine the frequency and mean score values. Besides, secondary data information was obtained through various references such as journal, article, website or report related to IR 4.0 implementation among skilled workers in construction industry. Moreover, the result showed that the biggest challenge of the IR 4.0 implementation was insufficient of skilled workers, and the influencing factor of IR 4.0 implementation was to reduce the project activity errors, as well as the step to improve IR 4.0 implementation was providing the training program. In conclusion,

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this research provided a better understanding of the potential of IR 4.0 implementation for improving construction's skilled workers.

Keywords: Construction Industry, IR 4.0, Skilled worker, Upskilling

1. Introduction

The Fourth Industrial Revolution (IR 4.0) is defined as a new shift from traditional operating procedures to modern operating procedures by utilising smart or advanced technologies that may boost productivity to an optimal level (Alaloul *et al.*, 2020). However, the performance of the industry is so reliance on the skilled workers, that the availability of skilled worker remains a major challenge within construction sector (Akomah et al., 2020). Accelerated technological improvements in the manufacturing process necessitate significant adjustments in the skills needed in the sectors, and flexible skill provisioning systems are required to adhere to shifting skill demands (Zaki *et al.*, 2012). For less-educated construction workers, the high complexity of technology becomes the more challenging part. Furthermore, technology adoption and deployment in the construction industry also are affected by a variety of factors such as reluctance to change, lack of knowledge, and insufficient information (Waziri *et al.*, 2017; Nnadi *et al.*, 2018). Therefore, this leads to incompatibility of the technologies with current construction practices.

As the COVID-19 pandemic in 2020, the construction operating process in the industry have changed, which has accelerated the construction industry to move toward Industrial Revolution 4.0 (IR 4.0), so upskilling of construction workers are needed to embrace new responsibilities arising from the influx of new technologies (Al-Lami, 2021). Due to the low level of IR 4.0 implementation in the Malaysian construction industry. This has resulted in construction workers not being able to familiarize themselves with the new technology in a timely manner. For example, an Industrialised Building System (IBS) was a technique of construction whereby parts are prefabricated within a surrounding that is under control, then hauled, located, and assembled into a structure without requiring much additional work on site (Alawag *et al.*, 2021). In comparison to traditional construction methods, modern construction required highly skilled workers as it is more of a machine-oriented skills whether on-sites or in factories. IBS deployment has proven to be more efficient and increased industry productivity (Enshassi *et al.*, 2019). Thus, production will be refactored into a fully integrated, automated, and optimised production process with the implementation of IR 4.0 technologies (Rubmann *et al.*, 2016).

The construction industry is crucial to a country's economic, which contributes to the jobs creation, the infrastructure development, and the expansion of the gross domestic product (GDP) (Tjebane *et al.*, 2022). The utilisation of smart and digital technologies such as IBS, Building Information Modeling (BIM), robotics, 3D printing, etc, has been shown to greatly improve project performance and productivity levels by saving the construction time. In addition to improvement of the project management life cycle, it could minimize costs, reduce construction defects and improve quality (Lat *et al.*, 2021). To ensure a high degree of technological adoption in construction, there should be an adequate supply of appropriately skilled workers to operate the technologies. Professional learning of new abilities, as well as the strengthening of on-site skillsets, necessitate special training (Lasi *et al.*, 2014). Thus, this results in a change that necessitates the reorganisation of an organization's workforce in terms of skills and retraining (Sashitharan *et al.*, 2014). As a result, the main aim of this study is to improve IR 4.0 implementation among skilled workers in the construction industry.

The business landscape in Malaysia has not been spared by the influx of the Fourth Industrial Revolution (IR 4.0), which engulfed the globe. This has prompted businesses to improve highly skilled workers in order to advance knowledge-based capabilities across a variety of industries, including Malaysia's construction sector. One of Malaysia's most pressing issues is the upskilling and retraining of skilled workers in the construction sector (Vinayan *et al.*, 2020). The goal to properly upskill and reskill worker capabilities in order to achieve maximum productivity has not been met by the existing highly academic supply-driven Technical Vocational Education and Training (TVET) system. Because of the constant changes in the corporate environment and the demands for jobs, there is a need to review and restructure the human resources to ensure that workers are highly skilled (Kenayathulla *et al.,* 2019). However, the prevalent issues with low-skilled worker involvement in construction can be traced to poor construction site safety, delays in on-site work schedules and reduced skilled workforce training programs (Hussain *et al.,* 2020). Furthermore, Zaki *et al.* (2012) stated that due to the construction sector's poor impression among Malaysian workers, companies would be forced to engage in foreign labour to meet labour needs, who are willing to deal with the lower incomes and poor workplace environments offered by construction sites.

Changes in construction technology advancements have resulted in changes in the demand for skilled workers of all kinds (Cascio & Montealegre, 2016). Skilled workers are those who have received professional training, have extensive work experience, are knowledgeable about construction materials, safety and equipment, as well as always in perfect spirits (Ahmed *et al.,* 2017). Fast expansion in industrial activity has caused an increased for skills, while training institutions have been unable to fulfill these requirements due to a variety of constraints (Zaki *et al.,* 2012). However, the most significant barrier to adopting the IR 4.0 technologies is the high capital cost (Pan *et al.,* 2012). The initial cost of equipment and technology is typically high. There are large investments required for plant setup, machinery and mould supply, engineering considerations in dealing with interface complexity, and transportation process expenditures (Alinaitwe *et al.,* 2006). Thereby, skilled workers are unable to learn and improve new skills because some small organizations not be able to invest in new technologies. Without sufficient knowledge and skills among the skilled workers, several more development projects would be delivered longer than planned, and the construction sector's growth will be slower (Sulaiman *et al.,* 2021). Hence, the necessity for skilled workers has surged, as have the employment kinds that meet the technical and professional aspects.

The evolution of construction modern technologies has a significant impact on the workforce (Cerika & Maksumic, 2017). Through the utilization of IR 4.0 new technologies, tools, and resources, bring good implications such as increased workplaces conditions, workers productivity, and environmental friendliness are available. However, to advance into the new IR 4.0 technologies, it is necessary to have a particular level of knowledge, there is a requirement for worker development and training, as well as a rising demand for integration skills (Zaki *et al.*, 2012). Due to rapid technological change, skills that have been thought would endure over time could quickly become obsolete among skilled workers, so developing new capabilities to ensure optimised project organisation and upskilling to the existing skilled workforce will face formidable challenges (Aripin *et al.*, 2019). The Construction Industry Development Board (CIDB) must take initiatives to boost the industry's visibility and enhance knowledge of the advantages of working in the industry among the local workforce (Fateh *et al.,* 2022). Meanwhile, in Malaysia, the utilisation of advanced construction technology could be helpful to minimize the massive number of foreign workers on-site while simultaneously luring local workers towards a more favourable workplace. Despite the ever-changing and the application of technologies in construction sector, a poor understanding of the advantages of applying these IR 4.0 technologies could be a barrier (Lasi *et al.,* 2014). Therefore, this research is to identify the key challenges, influencing factor, and steps for improving IR 4.0 among skilled workers in the construction industry.

This research will give more details on the benefit of improving IR 4.0 implementation among skilled workers in the construction industry. The stakeholder in the construction industry could improve the overall quality as well as reduce the reliance on the foreign labour. In addition, this research can also be used as a reference for the construction stakeholder on the improving IR 4.0 implementation among skilled workers in the construction industry. From this research, construction stakeholder will have a clear understanding of how to effectively implementation of new technologies to upskill and retrain the existing skilled workers to bring greater returns. Apart from that, this research is also vital for academics, especially students involved in the field of the construction industry. This study can serve as their further reference. Besides, this research conducts the IR 4.0 implementation for improving skilled workers and the challenges that will be faced by the technologies implemented in the construction industry. Thus, this research is expected to be used to improve the skilled workers through the implementation of IR 4.0 in the construction industry for scholarly reference related to the research.

2. Literature Review

2.1 Skilled Worker in the Construction Industry

The term skilled workers relate to human resources that possess specialised expertise, upskilling, and knowledge to perform more complicated physical activities than normal job obligations. Generally, it is distinguished by advanced or technical education, as well as skills gained via training and experience, which likewise correlates with higher salaries. In addition, skilled workers also possess advanced training, extensive working experience, and a thorough understanding of the knowledge relevant to their field (Ahmed *et al.*, 2020). Skilled workers are one of the most vital parts of construction projects. In this role, they perform construction work, assure product quality, employ materials and machinery, prepare construction sites, coordinate the supply chain on sites, and assure project deliverables and completion (Aiyetan & Das, 2018). In addition, the skilled workforce is a vital human resource for construction, and therefore, the industry's performance depends largely on the skills workforce. Also, the efficiency of skilled workers is one of the essential areas of labour productivity that requires more attention for successful project execution. Thus, the presence of skilled workers is regarded as an important part in the success of building projects (Jarkas, 2015).

2.2 IR 4.0 Implementation among Skilled Workers in Construction Industry

The Fourth Industrial Revolution (IR 4.0) or Industry 4.0 is a concept for the industrial growth procedure comprised of data interchange and automation, which has been recommended by the German federal government in 2011 as being one of the core goals of its high-tech strategy (Bahrin *et al.*, 2016). The core goal of IR 4.0 in the construction sector is to develop a digital construction site that utilizes variety of technologies to monitor progress throughout the life cycle of a project (Rastogi, 2017). The IR 4.0 implementation in construction industry includes interaction, technology, and coordination to improve the present construction procedure. Smart factories, modelling and simulation, virtualization and digitization as essential drivers for project management system, and digitized document management systems for information access have all been used to automate construction procedures and establish a modern construction circumstance (Oesterreich & Teuteberg, 2016). Hence, there are numerous types of technology used along with the IR 4.0 in construction industry such as discusses below.

(a) Building Information Modelling (BIM)

BIM was a novel method for construction design, operation, and maintenance in which a digital representation of the construction process is utilised to enable the sharing and interchange of digital information (Bryde *et al.*, 2013). It is a collaborative tool utilised by the construction industry that improves design visualisation and constructability, saves time and money, and decreases dispute among construction stakeholders (Azhar, 2011).

(b) Prefabrication and Modular Construction

Prefabrication and Modular Construction are two processes involved in the construction of buildings and infrastructure. Prefabrication is the technique of constructing structural components off-site at a factory and transferring them to the construction site as complete assemblies. Modular construction is a technique in which parts or modules are built off-site and then delivered to the construction site to be fitted and linked together (Buckley *et al.*, 2020).

(c) Autonomous Construction

Autonomous Construction is a modern kind of construction technology, that comprises the integration of computer software, mechanical and electronics to control robots by programming them to execute essential functions (Abd Rashid *et al.*, 2018). It is the combination of robots and information technology to aid in the planning, design, and cost estimation of a project. Automated machines could forecast the quantity of material required to accomplish the task, improving the workplace conditions and benefiting safety and health of workers (Aigbavboa *et al.*, 2021).

(d) Augmented Reality & Virtual Reality

Augmented Reality (AR) and Virtual Reality (VR) are two visualisation technologies which are revolutionising the method by which people communicate with visual data. It is also considered as a vital modern technology to improve the productivity on maintenance, decision-making, and infrastructure delivery (Demian *et al.,* 2020).

(e) Cloud & Realtime Collaboration

Cloud and real-time collaboration are a cost-effective, timely, and energy-efficient technology that enables remote access to information, applications, and services such as networks, storage, hardware infrastructures, and servers utilising only an internet connection (Bello et al., 2021). Furthermore, real-time cloud collaboration enables users to gain efficient and cost-effective access to on-demand computing and dynamic data storage resources (Balaji & Kalpana, 2021).

(f) 3D Scanning & Photogrammetry

3D scanning and photogrammetry have evolved as a technique that simplifies and accelerates planning, building, and phase monitoring. 3D scanning is the collecting of three-dimensional data from specified surface points of a certain object. Its major feature is the quick gathering of massive volumes of data within a small space of time. Photogrammetry techniques, on the other hand, rely on photographs collected from various angles to capture the building's or item's three-dimensional geometry *(Saari et al.*, 2021).

(g) Big Data & Predictive Analysis

Big data is identified as the high volume, variety, and velocity of information and data assets as well as novel data processing to enable improved insight, process automation, and judgement (Ram *et al.*, 2019). While the predictive analysis is a portion of big data. Predictive data analytics has been used to manage its various parties that involved in the construction industry, as well as develop solutions to alleviate the labour shortage, improve productivity, as well as reduce safety and health issues (Mahajan, 2021).

(h) Internet of Things (IoT)

The Internet of Things (IoT) is a network of things or items that may communicate with each other via smart phones, radio-frequency identification (RFID) tags, actuators, gauges, and so on, to achieve predetermined goals. In a broader sense, it is a global network of connected, globally accessible items based on common routing protocols (Arslan *et al.*, 2019). Besides, it makes use of network access and everything around it to connect and interact with each other in order to accomplish any specified activity via the network (Gamil *et al.*, 2020).

(i) 3D Printing & Addictive Manufacturing (AM)

3D printing or Additive Manufacturing (AM), are a relatively new form of technology that manufactures three-dimensional solid items. (Romdhane & El-Sayegh, 2020). Digital data is used to build the object layer-by-layer using different materials, such as metallic pastes, composites, ceramics, and polymers based on its requirements. Nowadays, 3D printing technology is being extensively explored in the construction sector as it enables layouts to be generated and executed quickly (Khajavi *et al.*, 2021).

(j) Advanced Building Materials

Advanced building materials are novel materials and techniques developed for the construction industry, with a particular emphasis on sustainable materials for the future construction industry. Acceptance of innovative building materials ought to be derived from meeting several of these criteria such as reliability, durability, sustainability, cost-effective, better quality, extreme situation adaptability, as well as stronger physical and mechanical properties, etc. (Bamigboye *et al.*, 2019).

(k) Blockchain

Blockchain is a distributed ledger technology that is a consensus of shareable and synced digital data that is globally scattered throughout various places, nations, or institutions (Wang *et al.*, 2017). Building construction is a collaborative process, with construction projects comprising a diverse range of construction players and agencies. The potential of blockchain could increase the construction players' confidence, transparency, accuracy, and immutability in the construction industry (Suliman & Jamal, 2022).

(l) Artificial Intelligence (AI)

Artificial intelligence (AI) is the engineering and science of creating intelligent equipment, particularly smart computer software. The objective of AI technologies is to enable machinery to replicate "intellectual" characteristics of humans, in order to undertake activities that humans ordinarily perform. Practically, AI functions are achieved by obtaining and analysing large amounts of data using specific algorithms (Mohamed *et al.*, 2021). Figure 1 has shown the numerous types of IR 4.0 technologies.

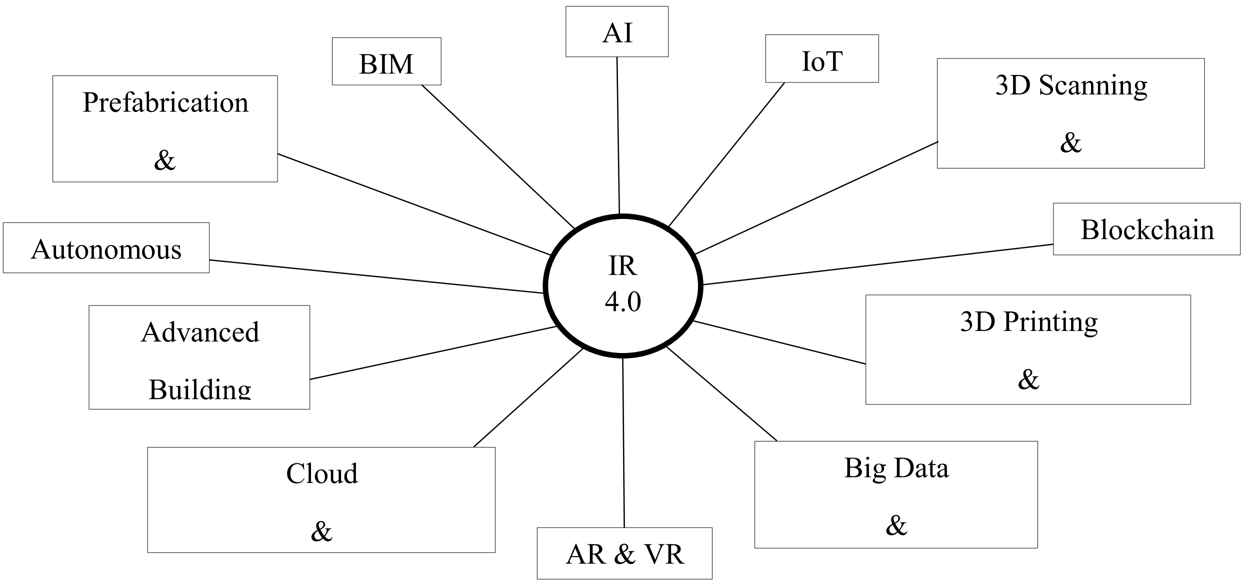

Figure 1: IR 4.0 technologies

2.3 Challenges of IR 4.0 Implementation

The first recognised challenge is the high implementation cost, which is problematic for firms seeking to maximise the gains of the IR 4.0. The expense of technical training and equipment upkeep are also hidden costs, which contribute to a difficult implementation process along with the uncertainties related to the return on capital (Alaloul *et al.*, 2020). Moreover, such training may entail the engagement of an outside consultant to advise the current employees, which can quickly add up in expense (Taher, 2021). Lack of willingness to adopt new technologies and innovations is the challenge along with the implementation of IR 4.0 in the construction industry, which causes resistance to change (Demirkesen & Tezel, 2021). The construction sector is well-known for its extreme opposition to change and emerging technologies, as well as its employees' traditionalism and reluctance to adapt (Oesterreich & Teuteberg, 2016). Furthermore, workers are concerned about job loss as a result of the implementation of new technologies, as automation, computing, or robotics may replace them.

Lack of standardization are the challenges that block the IR 4.0 implementation in construction industry. As there is a standard throwing across the stakeholders in an IR 4.0 network, the interconnection that facilitates complete digitalization and automation is unable to be realised (Jaafar *et al.*, 2018). Furthermore, the temporary nature of building projects causes unstandardized processes in the construction sector, making it difficult for companies to establish standard operating procedures (Demirkesen & Tezel, 2021). Without standardisation, the company will have difficulty governing and monitoring the IR 4.0 ecosystem (Weyer *et al.*, 2015). Data protection and cybersecurity are the challenges that block the IR 4.0 implementation in construction industry. The issue is that different cooperative organisations may have a varied cybersecurity hierarchy, which ultimately leads to protected information and data being hacked (Ling *et al.*, 2020). Demirkesen & Tezel. (2021) pointed out also the construction sector has previously been subjected to cyber attacks such as retrieving personal information, accessing unauthorised files, and deleting documents. Thus, the emergence of digital infrastructure on construction sites, as well as the transition to IR 4.0, are likely to raise the threat of cyber intrusions in the construction industry (Tirth & Vejal, 2020).

Skilled workers shortage is also among the barriers that discourage the IR 4.0 implementation in the construction industry. The usage of new technology necessitates a certain level of expertise. Because of the limited technical competency of construction workers on-site, there would be an increased need for training and development of workers, as well as integration capabilities (Oesterreich & Teuteberg, 2016). Furthermore, the construction sector is strongly reliant on a sufficient supply of qualified workers. An insufficient number of skilled workers graduating from training institutions and entering the labour market could lead to a cost and time overrun in the construction project (Varadarajah, 2020). Table 1 has shown the summary of the challenges of IR 4.0 implementation.

Table 1: Challenges of IR 4.0 implementation

No.	Challenges of IR 4.0 Implementation	Author
1	High implementation cost	• Alaloul *et al.* (2020) • Taher (2021)
2	Resistance to change	• Oesterreich & Teuteburg (2016) • Demirkesen & Tezel (2021)
3	Lack of standardization	• Jaafar *et al.* (2018) • Demirkesen & Tezel (2021) • Weyer *et al.* (2015)
4	Data protection and cybersecurity	• Ling *et al.* (2020) • Demirkesen & Tezel (2021) • Tirth & Vejal (2020)
5	Skilled workers shortage	• Oesterreich & Teuteburg (2016) • Varadarajah (2020)

2.4 Influencing Factors of IR 4.0 Implementation

Improving the quality are the influencing factor of the IR 4.0 implementation in the construction industry. The construction industry is focused on producing high-quality products (Oke *et al.*, 2019). The implementation of IR 4.0 such as Building Information Modelling (BIM) and other simulation technologies has been considered as a way to improve building quality since errors can be eliminated early on by replicating the entire construction process (Oesterreich & Teuteberg, 2016). Enhancing safety of the worker are the influencing factor of the IR 4.0 implementation on the construction site. The utilisation of modern technology such as BIM and drones reduces accidents by conducting remote inspections and detecting dangers, providing construction teams with critical information needed to maintain safety on workplaces (Alomari *et al.*, 2017). Therefore, the implementation of these technical breakthroughs helps to minimise the risks related to building projects by diverting the construction site away from highly dangers and toward low dangerous (Elrefaey *et al.*, 2022).

Improving the productivity are the influencing factor of the IR 4.0 implementation in the construction industry. BIM technology has regularly been integrated with other information technology, such as Radio Frequency Indentification (RFID), Geographic Information Systems (GIS), and sensor technology because it has the ability to enhance the productivity of workflow between construction players (Zhao *et al.*, 2019). Moreover, workers were able to develop multi-skilled resources to overcome resource planning issues, contributing to increased productivity and reduced fragmentation in prefabricated construction (Arashpour *et al.*, 2018). Skills enhancement of the workers are also the influencing factor of the implementation of IR 4.0 in construction industry. Job prospects in the future will necessitate the development of new capabilities, and it is vital to provide opportunities for skill acquisition thru high-quality training (Erol *et al.*, 2016). As automation and other technology take over duties previously covered by construction workers, the current positions will change (Joss *et al.*, 2019). Construction workers will have to be retrained and reeducated to get acquainted with the use of newer technologies (Tambi *et al.*, 2014). Table 2 has shown the summary of the influencing factors of IR 4.0 implementation.

Table 2: Influencing factors of IR 4.0 implementation

No.	Influencing Factors of IR 4.0 Implementation	Author
1	Improving project quality	• Oke *et al.* (2019) • Oesterreich & Teuteberg (2016)
2	Enhancing safety of workplaces	• Alomari *et al.* (2017) • Elrefaey *et al.* (2022)
3	Improving productivity	• Zhao *et al.* (2019) • Arashpour *et al.* (2018)
4	Skills enhancement	• Erol *et al.* (2016) • Joss *et al.* (2019) • Tambi *et al.* (2014)

2.5 Steps of IR 4.0 Implementation

The step of improving IR 4.0 implementation among skilled workers in the construction industry is the involvement and support from top management. The participation and support of the top management will be crucial for effective adoption of IR 4.0 (Shamim *et al.*, 2016). Sufficient organisational resources will be required to implement IR 4.0 (Jazdi, 2014). As a result, top management is highly significant inside the corporation, and it will help to overcome reluctance as well as will aid in the acceptance of IR 4.0 by many stakeholders. Providing the worker training and development is the step of improving IR 4.0 implementation among skilled workers in the construction industry. Training is a method of improving workers' capability and skills, enabling they can execute their tasks more effectively (Nda & Fard, 2013). Furthermore, training is an important practice for introducing modern technology, systems, or other advanced developments to workers. Thus, employees that learn about changes in work practices during the training program will help an organization by implementing new technologies (Periasamy *et al.*, 2020).

Improvement of project management is the step of improving IR 4.0 implementation among skilled workers in construction industry. Adoption of the IR 4.0 will be a range of operations that will be conducted in a well-planned and strategically timed manner to ensure its effectiveness (Rojko, 2017). Thus, project management concepts must be utilised critically to ensure their effectiveness. The typical project lifecycle stages of inception, planning, operation, control, and closeout will play a significant part in the implementation of IR 4.0 (Sony & Naik 2020). Government policies and initiatives is the step of improving IR 4.0 implementation among skilled workers in the construction industry. Government policies have a huge impact on IR 4.0 implementation, including subsidies for training workers to become digitally savvy (Wong *et al.,* 2020). The government's dedication to fostering the deployment of this technique can be seen in the establishment of the Construction Industry Development Board's (CIDB) Roadmap IBS 2011-2015, which established various well-thought-out strategies and proactive steps to encourage the utilisation of IBS (Kamaruddi *et al.*, 2018). Furthermore, BIM implementation will become mandatory for government projects of RM100 million or more by 2020, as stipulated by the Malaysian government. Table 3 has shown the summary of the steps of IR 4.0 implementation.

Table 3: Steps of IR 4.0 implementation

No.	Steps of IR 4.0 Implementation	Author
1	Involvement of top management	• Shamim *et al.* (2016) • Jazdi (2014)
2	Training and development	• Nda & Fard (2013) • Periasamy *et al.* (2020)
3	Improvement of project management	• Rojko (2017) • Sony & Naik (2020)
4	Government policies and initiatives	• Wong *et al.* (2020) • Kamaruddi *et al.* (2018)

3. Research Methodology

3.1 Research Design

This section describes the approach which was employed in this study. Furthermore, this chapter will present the research process, research population and sampling, data collection methods and data analysis methods for accomplishing research objectives are introduced. Figure 2 below has shown the research process flow chart.

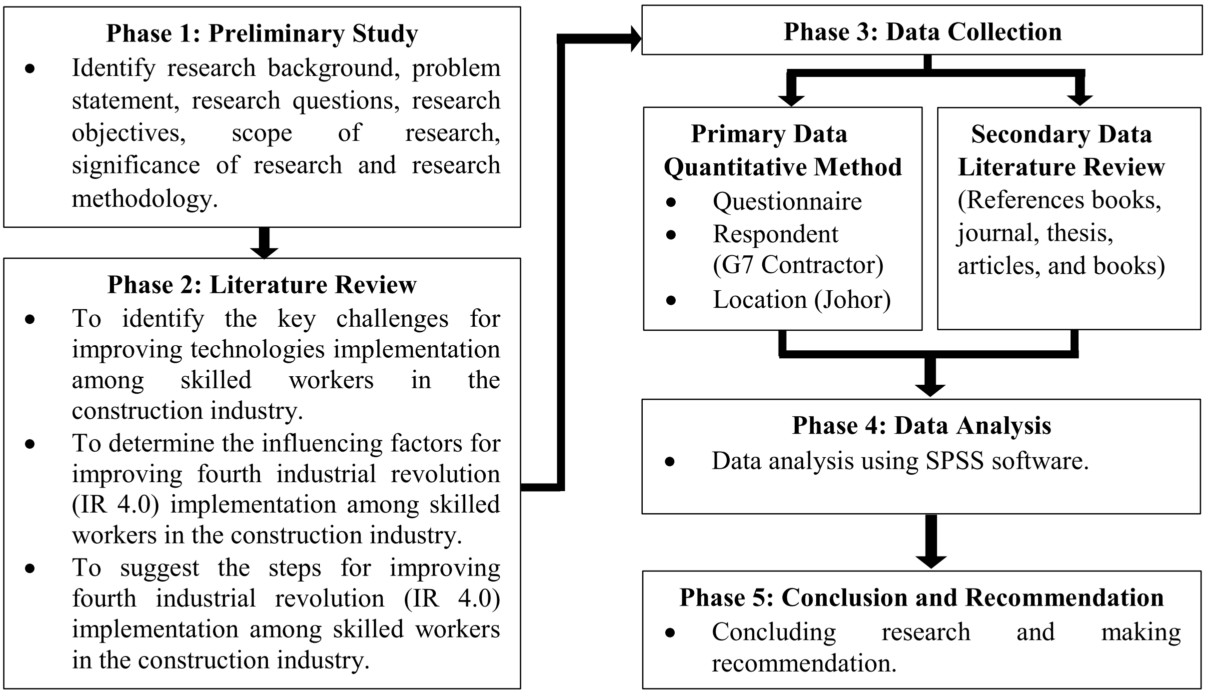

Figure 2: Research process flow chart

A quantitative method was utilised for this research. Quantitative method are used to describe a phenomenon or issue by gathering numerical data and analysing it using mathematical techniques, notably statistics (Apuke, 2017). This study employs a cross-sectional design as a sort of observational study design and will utilize questionnaires as the data collection method (Leone *et al.*, 2018). Following that, data gathering, and data analysis was included, both of which have a numerical value. The questionnaire form was used as the main tool for gathering primary data for this research. The questionnaire form is utilised to gather the facts and data required to address the research question from many perspectives. The data is obtained by measuring items and investigating them through numerical comparisons, as well as reporting the data through statistical assessment (Asenahabi, 2019). Google Forms was used to create the survey questionnaire for this study. In this study, the gathered results and data from the respondents, as well as the literature review was studied and analyzed to accomplish the research objectives.

3.2 Data Collection

This research consists two types of data, which are primary data and secondary data. All the information was gathered through this primary data and secondary data. Thus, the method of data collection was explored in depth. A questionnaire was distributed to the target respondents to gather the primary data for the study by using the quantitative method. The questionnaire was concentrated on the research objectives, which are to ensure that it is achieved. The form of the questionnaire can be referred to the Appendix A. The questionnaire was prepared on Google Forms and disseminated by e-mail and Whatsapp. The respondent of this questionnaire consists of 708 G7 contractors at Johor. Hence, the number of 248 was taken as the sample size according to Krejcie and Morgan Sampling Method (Krejcie and Morgan, 1970). Besides, data collected from sources that have been released in any form is called secondary data. The secondary data collection sources are references, journals, papers, articles, titles-related publications, etc. (Kabir, 2016).

3.3 Data Analysis

Data analysis as a procedure of collecting, analysing, and evaluating the data to get findings which can be utilised to make decisions (Pal, 2017). The primary goal of data analysis is to transform relevant complicated data in a manner that is more readable easy to understand, clear, and helps the decision-making mechanism (Bathia, 2017). Moreover, the data received from the completed questionnaire was analysed using SPSS software. The gathered data was analyzed to achieve the accurate and valid answers before being submitted as research results. The analysis was accomplished to obtain the frequency, percentage and mean score values that will display in the form diagrams, tables, or graphs.

4. Results and Discussion

4.1 Response Rate & Reliability Test

A total of 145 out of 248 respondents were collected through the distributed questionnaire. The percentage of questionnaire collected from the respondent is 58.5% out of 100%. The Table 4 has shown the rate of the questionnaire distributed, received, not received with its percentage respectively.

Table 4: Response rate of questionnaire survey

Questionnaire	N	Response Rate
Questionnaire Distributed	248	100%
Questionnaire Received	145	58.5%
Questionnaire Not Received	103	41.5%

In this research, the reliability test was evaluated using Cronbach's Alpha and 145 sets of questionnaires were used for the variable reliability test. An alpha value below 0.6 is considered poor. If the Alpha Coefficient is from the 0.6 to 0.7, the reliability is moderate. On the other hand, Alpha Coefficient from 0.7 to 0.8 shows that the reliability is good. Meanwhile, the value of alpha between 0.8 to 0.9 is consider very good. Lastly, an alpha coefficient of over 0.9 indicates excellent reliability. Hence, Table 5 has shown the reliability statistics of the 145 questionnaires which were 0.915 considered excellent, which included 44 items for the respondents' backgrounds and the three primary objectives of the research.

Table 5: Reliability statistics

Coefficient Alpha, α	Number of Item (N)
0.915	44

4.2 Descriptive Analysis

Descriptive analysis was used to summarize data in an organized manner by describing the relationship between variables in a sample or population. It included types of variables and measures of central tendency as well as frequency. All descriptive statistics were displayed in the form of frequency, percentage, average, and standard variation among various types of graphs, charts, and tables between the techniques used (Stoltzfus *et al.,* 2018). Thus, this research was completed to study the key challenges, influencing factors and steps for improving IR 4.0 implementation among skilled workers in the construction industry. A collection of data from the questionnaire is presented and discussed based on a quantitative analysis methodology (Freeman, 2018). As shown in Table 6, SPSS software was used as the analysis method to determine the mean value and the ranking level whether is higher, moderate, or lower.

Table 6: Average index mean scale (Freeman, 2018)

Average Index	Level
1.00-2.40	Lower
2.41-3.80	Moderate
3.81-5.00	Higher

4.3 Respondent's Background

Table 7 below have shown the summarization of the respondent's background, including highest academic qualification, job position, working experience, level of IR 4.0 usage in the construction industry, and usage of IR 4.0 technologies in the construction industry. The frequency and percentage were summarised from the responses of 145 respondents. Based on Table 6 below, most of the highest academic qualification was bachelor's degree 53.1%, because the field of study was mainly in bachelor's degree. As a result, this demonstrated that the bachelor's degree was highly participative. Moreover, project managers accounted for the majority of job position at 26.2%. Furthermore, most of the respondents had working experience with 10 years and above at 34.5%, indicating that they have more experience in the construction industry. Following that, the level of IR 4.0 usage in the construction industry is high at 63.4%. Lastly, with a total of 63.6%, the Internet of Things is commonly used as a IR 4.0 technology in the construction industry. This is because the Internet of Things is an essential technology for most of the construction firm.

Table 7: Respondent's background

Item		Frequency	Percentage (%)
Highest Academic Qualification	Diploma	38	26.2
	Bachelor Degree	77	53.1
	Master	17	11.7
	PhD	10	6.9
	Other		
	(SPM)	2	1.4
	(EMBA)	1	0.7
Job Position	Site Supervisor	26	17.9
	Architect	19	13.1
	Engineer	23	15.9
	Project Manager	38	26.2
	Site Manager	33	22.8
	Other		
	(Quantity Surveyor)	5	3.4
	(Assistant Engineer)	1	0.7
Working Experience	1 – 3 years	21	14.5
	4 – 6 years	39	26.9
	7 – 9 years	35	24.1
	10 years and above	50	34.5
Level of IR 4.0 usage in the construction industry	High	92	63.4
	Medium	40	27.6
	Low	13	9.0
Usage of IR 4.0 technologies in the construction industry	Building Information Modelling	56	38.4
	Internet of Things	93	63.6

Prefabrication & Modular Construction	65	44.5
Autonomous	42	28.8
3D Scanning & Photogrammetry	20	13.7
3D Printing	31	21.2
Big Data & Predictive Analysis	41	28.2
Advanced Building Material	38	26
Augmented Reality & Virtualization	8	5.5
Blockchain	6	4.1
Cloud & Realtime Collaboration	49	33.6
Artificial Intelligence	9	6.2
None	4	2.8

4.4 Key challenges for improving technologies implementation

According to Table 8 below, the highest mean of the key challenges for improving technologies implementation was "Insufficient of qualified workers" with 3.9379, ranked 1 and the standard deviation was 0.944. The construction industry actually deals with capital and new technologies, which indicates that high-skilled workers are needed for the implementation of technology. Due to over-reliance on foreign workers that possess low technical skills to fill in the gap, indirectly caused the shortage of skilled workers in the construction sector (Sulaiman *et al.,* 2021). Moreover, the lowest mean of the key challenges for improving technologies implementation was 3.5448 ranked 15 which was "Fear of job losses", and the standard deviation was 1.041. Since the nature of the construction sector relies on labour, skilled labourers are still required to master new technologies despite rapid industrialization in the construction industry. In this respect, more skilled workers are required to deal with advanced technology (Manap *et al.,* 2017). Most of respondents believed that the fear of job losses was not the main issues that hinder the technologies implementation among skilled workers in the construction industry. Therefore, the descriptive analysis determined the total average mean was 3.767 which is between 2.41 to 3.80 so it is considered medium.

Table 8: Key challenges of technologies implementation

No.	Item	N	Mean	Standard Deviation	Ranking
1.	Insufficient of qualified workers	145	3.93	0.94	1
2.	Lack of competence to learn new techniques	145	3.91	0.91	2
3.	High expenses of expertise employee	145	3.87	0.94	3
4.	Concerns of data information protection	145	3.86	0.94	4
5.	High cost of skills training	145	3.85	0.95	5
6.	Threat of cyber intrusion	145	3.84	0.89	6
7.	Unawareness of the essential technical knowledge	145	3.80	0.99	7
8.	Lack of willingness to adopt new technologies	145	3.73	1.01	8

9.	Interconnection realization between digitalization and automation	145	3.77	0.93	9
10.	Lack of skilled trainers	145	3.75	0.95	10
11.	Data fragmentation for technology implementation	145	3.73	0.95	11
12.	Difficult to establish standard operating procedures	145	3.67	1.00	12
13.	Return on investment (ROI) in technologies is uncertainty	145	3.64	1.05	13
14.	Inaccuracy of the project information	145	3.63	1.00	14
15.	Fear of job losses	145	3.54	1.04	15
	Total Average Mean		3.767		

4.5 Influencing factors for improving IR 4.0 implementation

According to the Table 9 below, the highest mean of the influencing factors for improving IR 4.0 implementation was "Reduce project activity errors" with 4.1379, ranked 1 and the standard deviation was 0.838. The implementation of IR 4.0 can reduce project activity errors compared to the tasks that are manually handled by the labourers, as each automated mechanisation will be integrated via technological developments to execute and share data without the involvement of humans (Zawawi *et al.,* 2016). However, the lowest mean of the influencing factors for improving IR 4.0 implementation was 3.7586 ranked 12 which was "Shielding workers from incident", and the standard deviation was 0.937. The construction industry was regarded as the most hazardous in terms of occupational safety and health because of the unique nature of the processes involved. As the continually changing work environment exposed employees to new hazards that could appear undiscovered (Halim *et al.,* 2020). Thus, the descriptive analysis determined the total average mean was 3.931 which is between 3.81 to 5.00 so it is considered higher.

Table 9: Influencing factor of IR 4.0 implementation

No.	Item	N	Mean	Standard Deviation	Ranking
1.	Reduce project activity errors	145	4.13	0.83	1
2.	Producing high quality of project	145	4.08	0.87	2
3.	Optimise the construction processes	145	4.05	0.83	3
4.	Improve productivity of the workflow	145	4.04	0.85	4
5.	Necessitate the development of new capabilities	145	3.94	0.91	5
6.	Interact and collaborate in real time	145	3.91	0.89	6
7.	Providing critical information about safety on workplaces	145	3.88	0.89	7
8.	Improve collaboration among workers	145	3.86	0.88	8
9.	Develop multi-skilled of workers	145	3.84	0.92	9
10.	Retrain and reeducate with the use of new technologies	145	3.83	0.90	10
11.	Conducting remote inspections	145	3.82	0.90	11
12.	Shielding workers from incident	145	3.75	0.93	12
	Total Average Mean		3.931		

4.6 Steps for improving IR 4.0 implementation

Based on Table 10 shown below, the highest mean of the steps for improving IR 4.0 implementation was “Provide the training program” with 4.1862, ranked 1 and the standard deviation was 0.808. Training is an approach to enhancing the employee's ability and skill so that they can undertake their tasks more effectively. It is an essential process for introducing new technology, systems, or other cutting-edge innovations to employees (Mckee & Gauch, 2020). Next, the lowest mean of the steps for improving IR 4.0 implementation was 3.9103 ranked 12 which was “Government provides subsidies for worker training” and the standard deviation was 0.935. The subsidies provided by the government is not enough overcome all the challenges that arise as a result of the economic turbulence, especially in the pandemics (Antipin & Ilyashevich, 2021). Some of the respondents implied that the subsidy application process is cumbersome, and the government tends to provide subsidies to enterprises with lower incomes. Therefore, the descriptive analysis determined the total average mean was 4.044 which is between 3.81 to 5.00 so it is considered higher.

Table 10: Steps of IR 4.0 implementation

No.	Item	N	Mean	Standard Deviation	Ranking
1.	Provide the training program	145	4.18	0.80	1
2.	Top management provide financial support	145	4.17	0.90	2
3.	Top management leads the widespread of IR 4.0 implementation among workers	145	4.13	0.89	3
4.	Provide sufficient financial support on training	145	4.07	0.84	4
5.	Provide the IR 4.0 education via TVET	145	4.06	0.86	5
6.	Mandatory of the IR 4.0 utilisation	145	4.06	0.89	6
7.	Improve the handling of the project	145	4.04	0.83	7
8.	Top management solve the inadequate of resources	145	4.02	0.85	8
9.	Improve project lifecycle	145	3.97	0.87	9
10.	Enrich the efficiency of workers	145	3.93	0.82	10
11.	Improve project management concept	145	3.93	0.89	11
12.	Government provides subsidies for worker training	145	3.91	0.93	12
	Total Average Mean			4.044	

5. Conclusion and Recommendation

In conclusion, all the research objectives were accomplished by the questionnaire distributed to G7 construction companies in Johor using the quantitative method. This research has demonstrated that the data analysis of the questionnaire by using the SPSS software, has successful in achieving all of the study's objectives. The results show that the most challenges faced by the construction industry for improving IR 4.0 was the insufficient of qualified workers due to Most owners or contractors prefer the conventional method instead of new technology. This willingness of workers to learn new technologies will be reduced in a less competitive environment. The influencing factors of IR 4.0 implementation is reducing the project errors. The respondents believe that the implementation of IR 4.0 can increase worker efficiency, thereby reducing errors in the workplace. The steps of IR 4.0 implementation is to provide the training program. There is a respondent implied that the both existing and new workers need training to take the advantages of new technologies. However, there were numerous challenges and limitations faced by the researcher during the data collection. This has a relatively limited impact on data collecting and analysis. Some of the targeted respondents refused to give feedback on the survey questionnaire because they were overly busy, thereby they did not complete the surveys. Next, the delivery of questionnaires to respondents was unsuccessful due to invalid and unavailable email addresses. Furthermore, not all G7 contractors are suitable to respond to this questionnaire; only G7 contractors with IR 4.0 experience are qualified. Lastly, some respondents are unmotivated to complete the questionnaire, and others take a while to resolve the issue. Therefore, the cumulative data gathered by the researcher was 145 out of the total 248 respondents.

Moreover, the contribution of this research to the construction industry is that the contractors or others stakeholders can better understand the benefit of the IR 4.0 implementation and have a clear direction for the implementation of new technologies to upskill and retrain the existing skilled workers in order to solve the insufficient of skilled worker in the construction industry. Besides, this research also has contributed to the academics, especially students involved in the construction field. This study may be applied as their further reference if they continue to involve themselves in the field of construction. Lastly. there are some recommendation and suggestion that given to the organization that implement IR 4.0 for improving skilled workers in the construction industry and for future study. The recommendation for the construction industry is to implement the IR 4.0 as its benefit is far more than the conventional method. The IR 4.0 technologies implementation can help to enhance the workers and the project performance. Furthermore, an effective training programme for the use of new technologies must be delivered to construction workers on the workplace to raise their level of competence and skill. Furthermore, the recommendation for future research was provided according to the findings of this study. In the future, any researcher who desired to conduct the research in this area of study, it is suggested to combine two research methods which is quantitative method and qualitative method. Thus, this will provide a clear understanding of the report findings through the combination of these two research methods.

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