

## **The Current State of the Implementation of Mechanisation and Automation (M&A) in Industrialised Building System (IBS) in Construction Industry**

**Siti Syariazulfa Kamaruddin<sup>1,\*</sup>, Mohammad Fadhil Mohammad<sup>2</sup> & Rohana Mahbub<sup>2</sup>**

<sup>1</sup>Department of Quantity Surveying, Faculty of Built Environment, Universiti Malaysia Sarawak, Sarawak, Kota Samarahan, Sarawak, 94300, MALAYSIA

<sup>2</sup>Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam, 40000, MALAYSIA

\*Corresponding Author

DOI: <https://doi.org/10.30880/rmtb.2021.02.02.050>

Received 30 September 2021; Accepted 01 November 2021; Available online 01 December 2021

**Abstract:** Integrating Mechanisation and Automation (M&A) in the construction process is necessary to less dependency on labour, reduce production time and costs, improve working conditions, avoiding dangerous works, allow work to be performed where people cannot do, and eventually will increase performance, and product quality. This paper discusses the current state in the implementation of M&A in the Industrialised Building System (IBS) approach. Qualitative and quantitative research was conducted in this research. G7 at Klang Valley was been respondent in this research. A questionnaire (80 respondents) and a semi-structures interview (10 respondents) had participated in this research. Descriptive analysis (SPSS) and the thematic analysis using in this research to analysed data have been collected from questionnaire form and interview form. From the data analysis result, the reduction in depending on foreign labour are the most significant driving factors in the implementation of M&A. Furthermore, the high capital cost can be reduced after a long-term construction in the implementation of M&A. Also, the government support and promoting is important in term of fund and tax incentive in the IBS project among the G7 construction company in Klang Valley. This research can provide an insight into the implementation of M&A on the ways of looking forwards to industrialisation in order to create sustainability in IBS construction.

**Keywords:** Mechanisation and Automation (M&A), Industrialised Building System (IBS), Construction Industry

### **1. Introduction**

To fulfil the government's aspiration to transform the Malaysian construction industry into a modern construction system and accomplish the implementation of the IBS Roadmap and Construction Industry Master Plan (CIMP) 2006-2015, proper and structured planning and implementation of Mechanisation and Automation (M&A) approach for IBS should be established. The CIMP was introduced to improve the performance of the construction industry by providing a series of seminars, workshops, training courses, and awareness upraising events. By virtue of Strategic Thrust No. 3, it was aimed to improve the quality of work, safety, and health, as well as environmental practices. However, this guideline was not enforced by the government. Consequently, the Malaysian contractors seemed to apply their policies and guidelines pertaining to IBS construction which clearly do not reflect the existing initiatives implemented by the Malaysian government (Nawi *et al.* 2014). Various initiatives have been implemented by the government to resolve the issues concerning the implementation of IBS in Malaysia. In September 2015, the CIDB had launched the Construction Industry Transformation Programme 2016-2020 (CITP) as the continuation of CIMP 2006-2015 to ensure continuity and consistency with the national agenda in achieving the Eleventh Malaysian Plan thrusts. Four strategic thrusts have been introduced in the CITP to lead the transformation of the construction industry; which are a) Quality, Safety and Professionalism, b) Environmental Sustainability c) Productivity, as well as d) Internationalisation (CIDB, 2015). Therefore, according to Yusof (2017) a CIDB's study conducted in 2014 that as of May 2016, about 69% of government projects use IBS, while the adoption rate by the private sector is still low at only 14%. Besides, Ismail *et al.* (2019) the promotions, incentives, policies, and development efforts from the government may be able to raise the demand and supply of IBS in Malaysia.

The issues of an affordable home in Malaysia are crucial -since the price of housing increases every year. In recent years, house prices in the city centre are exorbitant for the people. The biggest effect of the houses price was the land itself. When restricted by the constraints of space, cost, or materials, there was a great challenge but also a great opportunity to design homes that are not just functional but liveable. As cities continue to grow, affordability and availability of living spaces become increasingly problematic. Malaysia housing department focused on various segments of society and on boosting socioeconomic status, built environment, safety and, comfortable (10th Malaysian Plan). PRIMA housing was an example of an affordable home that is supposed to use modular construction in Malaysia as planned by the government. This study recommends that the implementation of M&A in IBS has to be considered in give industry players to move towards IBS. There are some critical issues on IBS construction in Malaysia which mostly IBS projects use the traditional approach in construction (Nawi *et al.* 2013). The introduction of IBS in Malaysia has made a strong impact on the local construction industry. The IBS project has competitive advantages in promoting sustainable construction, even though it has yet to attain the level of technology adopted by developed countries (Hamid & Kamar, 2012; Kamaruddin, Mohammad, Mahbub, & Ahmad, 2013). IBS is an innovative construction system that represents a specialised construction method that adopts prefabricated or precast components through off-site construction or modularisation.

One option to address the construction industry problems is to move towards industrialisation by adopting M&A in the construction industry. In the construction industry, time is money. Since M&A is considered faster than humans at work operations, contractors should expect to complete projects sooner when using these technologies. Adding to that, industrialisation is a part of a wider modernisation process through the revolution and the development of modern methods of production and technology system, mainly factory production (Lessing, J., 2006). As for that matter, one of the most influential studies on industrialisation categorization in construction was the work by Roger-Bruno (Richard, 2005).

According to CIDB, (2012) the construction industry is also struggling to cope with issues related to performance, productivity, environment, and health and safety, and to deal with the influx of foreign labour in construction sites. Besides, the context of the Malaysian construction industry has currently

been transformed into a mass production developing the standardisation of products in line with the global market (Azman, M.N.A & Ahmad, M.S.S. 2010). Other than that, the construction industry is highly concerned with addressing the evaluation of manufactured products in relation to enhancing sustainability and waste generation (Mohammad *et al.* 2014). In fact, until the 20th century, M&A in the construction industry was meant to be moving earth with the hand shovel (Sadique *et al.* 2016). This is true, the introduction of earthmoving machines by Benjamin Holt marked the real labour-saving method in the construction industry. Hence, mechanisation equipment is classified into four depending on its application. It includes earthmoving equipment's that can be used for compaction, clearance of the site, etc.; construction vehicles like dumpers, trailers that can be used loading and unloading; material handling equipment's for moving materials which earlier was labour-intensive work and finally, construction equipment's that can be used to do risky and dangerous construction works like tunnel boring (Mahbub, 2012). Despite the technologies improved the machine started rendering the whole process and this lead to automation.

The lesson learned from the 9th Malaysian Plan indicates that the construction sector did not grow at 6% per year during the 2005-year plan period. There are many underlying causes for this slow growth rate; however, the most notable is slower construction activities in the civil and non-residential sub-sectors. The implementation of the 10th Malaysian Plan envisaged a high-income economy with higher productivity. In Malaysia, during this plan period (2011 – 2015), the government allocated RM138 billion for the development of physical infrastructure. During this period, 52 mega projects were funded from various sectors, such as highways, power stations, double track train project, LRT expansion, Iskandar development, Greater KL etc. (Knutson, *et al.* 2007). The timely and successful completion of these projects requires enhanced productivity, quality, efficiency and high-class workmanship. In order to achieve these goals and optimise cost, the local construction industry needs to adopt mechanisation, automation and robotics through the IBS construction approach.

YAB Dato' Seri Najib Tun Razak (6th Prime Minister of Malaysia) pushed for new technologies, mechanisation and automation during his opening speech at the International Construction Week (ICW) 2012. He further emphasised that the government would take all the necessary measures and provide support through its encouraging policies and regulations for the adoption of M&A in the industry. He further said that "Labour intensive industries such as the construction industry must shed their traditional dependency on labour and focus on alternative production inputs that can boost productivity". The Malaysian construction industry is labour intensive. It involves thousands of skilled and semi-skilled workers and comprises of a large proportion of foreign labour as well (Idoro, 2004).

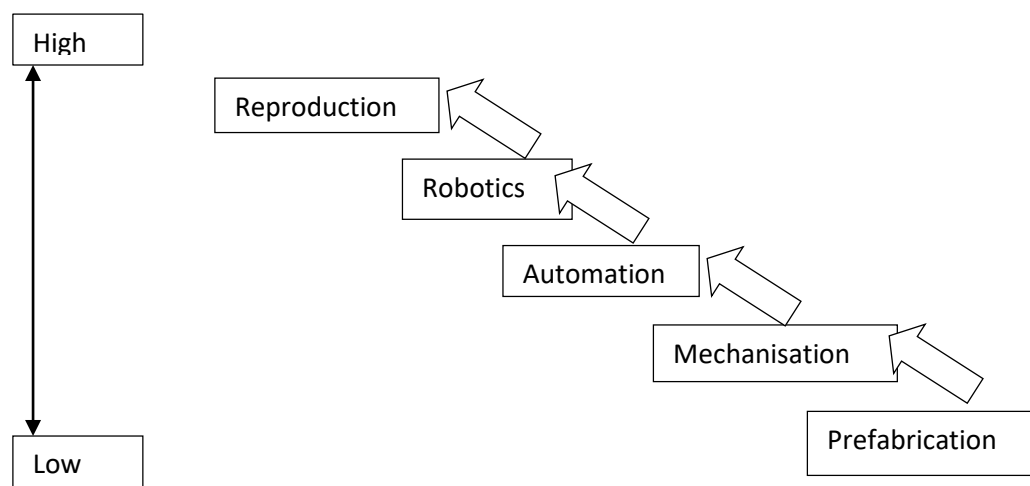
However, the implementation of free flow of workers within the ASEAN countries by 2015 will bring a pressure on the construction job market of the country (Yue, 2011). Furthermore, the Government is determined to realise free market strategies through liberalisation of regional economic accords. With these policies and reforms, it is not possible for the construction industry to flourish by relying on cheap labour. The dependency of foreign skilled labours is also acts as an inhibitor to the growth of the construction sector during the 10th Malaysian Plan period. In this scenario, mechanisation and other technological methods must be encouraged in order to achieve the maximum yield of construction workers.

M&A technologies are widespread within many manufacturing sectors today. Studies which have been done by Maeda (1986) in Japan, states that the renewal market is expected to grow in the near future, through findings from the Building Contractors Society of Japan which has surveyed mechanisation or automation systems suited to the renewal since 2001. It is widely accepted that some of these technologies can be implemented in, such as mechanisation that can be described as the process of applying the use of mechanical plants in carrying out a task. The level of mechanisation is defined as the number of plants and equipment employed or the number of activities carried out by mechanical

plants in an operation (Idoro, 2008). It can also be defined as the act of implementing the control of equipment with advanced technology, usually involving electronic hardware.

Based on the studies done by Parker (1993) and Navon (1996) automation is defined as “the replacement of human labour by machines; or the operation of a machine or device automatically, or remote control”. Automation can also be defined as a self-regulating process performed by using programmable machines to carry out a series of tasks. The automation goes one step further than mechanisation in that the process is not only supported by machines, but these machines can work in accordance with a programme that regulates the behaviour of the machines (Mahbub, 2008). The definitions can be viewed in terms of the sophistication in technology application between mechanisation, automation and robotics. At one end of the spectrum is mechanisation, which involves the act of equipping a process with machinery. The machinery used may be so technologically advanced that it would render the whole process automatic.

In this case, the mechanisation process has become an automated process, where it goes one step further and the process is not only supported by machines, but these machines can work in accordance with a programme that regulates the behaviour of the machines. Other than that, the most sophisticated and advanced application would be that of robotics, where task specific, dedicated robots performing discrete tasks on simplified building technology are used (Mahbub & Humphreys, 2005). This is in line with the statement from Richard (2005), who described five degrees of industrialisation which are prefabrication, mechanisation, automation, robotics and reproduction as illustrated in Figure 1.



**Figure 1: Degree of industrialisation (Richard, 2005)**

Based on the Figure 1, prefabrication is a manufacturing process that takes place in a specialised facility, in which various materials are joined to form a component part of the final installation. Mechanisation comes in whenever machinery is employed to ease the workload of the labourer. On the other hand, automation is a situation when the tooling (machine) completely takes over the tasks performed by the labourer. Robotics comprises of the ability of the same tooling which has a multi-axis flexibility to perform diversified tasks by itself. This allows for the mass-customisation concept. Reproduction implies that the research and development of innovative processes is truly capable of simplifying the production process. The first four degrees (prefabrication until robotics) are still more under the influence of the traditional methods of building. Prefabrication aims rather at the location of the production where the next three degrees (mechanisation, automation and robotics) aim at substituting labour with machineries (Richard, 2005).

Work on mechanisation and automation of engineering and construction work has been initiated independently in a number of countries in the seventies as a reaction to the success of industrial robotics,

which raised high hopes for substantial growth of efficiency in the construction industry, for a reduction in the number of accidents, and improvement of working conditions, and making the work itself more attractive. Initially, those activities concentrated principally on developing automatic control systems in various groups of machines and equipment, and on the adaptation of industrial robots to selected types of construction work.

Hence, the M&A approach has in many aspects proven to become more sustainable in terms of cost, time and quality through the IBS approach. However, the value creation of IBS can only be enhanced using appropriate mechanisation and automation manufacturing processes which are different from the current conventional projects. Adopting M&A will reduce the construction activities on site to just a simple transport and assembly processes and thus, becomes less complex. The statement has been proven by findings from Egan (1998) and Hansson (1996). Mechanisation and automation are the basis of pre-assembly and standardisation include speed of construction, lower cost, reduced need for skilled labour, high technical quality, reduction in manufacturing costs, fewer interface and tolerance problems, shorter construction periods, and more efficient research and development of components. Clearly, if Malaysia wishes to imitate the success of others developed countries and parallel with the government's goal, the industry must move forward and the industrialisation of building and construction sector should be pursued (Kamar, 2012). The efficiency and productivities of this industry can be improved by employing existing as well as emerging M&A technologies available on the market today.

## 2. Research Methodology

The research methodologies employed were literature review and qualitative semi structures interviews is updated by collecting among the expert's panels in perception, experience, and comments to understand the current state in the implementation of mechanisation and automation towards the IBS project. Literature review was the first phase of the research. Secondary data were derived from relevant books, journal articles, conference proceedings, and reports.

There are many types of interviews notably unstructured, semi-structured, and structured interviews and each appropriate in different circumstances (Leech, 2002). In this primary data collection, this study mainly aims to collect industry players' feedbacks and experiences on the constraints of implementing M&A to conventional projects. This study focuses on a semi-structured interview because a semi-structured interview is useful for investigating opinions and collecting experiences (Clifford *et al.* 2016).

The Delphi method has been chosen to conduct the integral part of the preliminary study. The Delphi method can be defined as a beneficial multi-step structured communication process to achieve an unanimity response from a group of experts on problems related to the subject matter (Alexander & Serfass, 1999). Supported by Harold & Muray (1975) the Delphi method is a structured communication technique, originally developed as a systematic, interactive forecasting method which relies on a panel of experts.

## 3. Findings and discussion

The issues of current state of M&A adopted in IBS has been the subject of considerable debate and critique since it is linked to the current IBS adoption is still low and the target has not been achieved. Thus, the qualitative approach utilising semi-structured face to face interviews were conducted to explore the current state of M&A adopted in IBS approach. The objective of this serve is to gain information on the issues of implementation of M&A in IBS approach. The exploratory semi-structured interviews were chosen at this stage based on the opinion of Cresweel (2009) who states that the intention of interviews is to elicit the interviewees' experience, opinions and perceptions regarding a

particular phenomenon whilst exploratory interviews frequently covers emotionally loaded topics. This requires skill of the interviewer to enable the respondents to talk freely and emotionally for the richness, depth, candour, authenticity and honesty about their experiences.

Most researchers who employ the interview method heavily refer to the work of Smith (1995). He described that common interview types are structured, non-structured, and semi structured. The classification of interview types depends on types of constructing questions. However, the Delphi Method is preferred in this case. Based on the interview objective, the instrument of research and the respondents' participation, the Delphi application method implemented in this interview research is the semi structured interview. Apart from that, it also focuses mainly on the topic to be discussed where the goals of the interview can be achieved accordingly.

The sampling frame for this study is the 10 expert panels members to explore the current state of M&A ad adopted in the IBS approach. Ten expert panels are selected according to research size and topics to be discussed. The current state of M&A in the local and global context derived from relevant sources are elaborated upon. Therefore, the interview is untended to validate and develop a ranking for critical factors of M&A. In this case, based on the guideline of Delphi Method, a number of 10 expert panel members are adequate to validate and rank critical factors in the implementation of M&A as it does not involve a large population of study.

Table 1 illustrates the respondents' profile including their years of experience, designation, and their appropriateness to be respondents of the interview session.

**Table 1: Respondent's profile of exploratory interview**

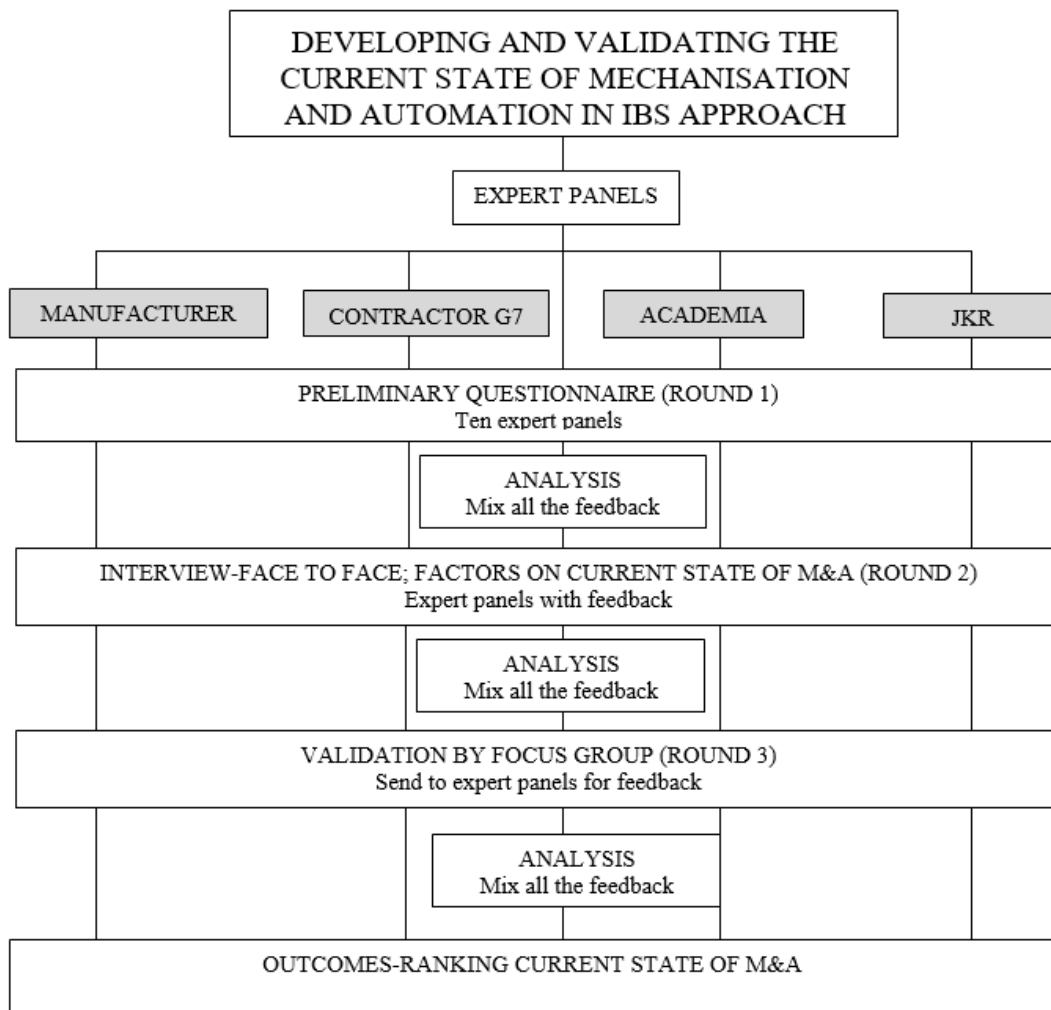
Expert Panel	Designation	Experience (Years)	Organisation
Panel 1	Operation Manager	20	Manufacturer
Panel 2	Senior Manager	35	Manufacturer
Panel 3	Engineer	25	JKR
Panel 4	Quantity Surveyor	10	JKR
Panel 5	Project Manager	10	Contractor
Panel 6	Manager	8	Contractor
Panel 7	General Manager	7	Contractor
Panel 8	Senior Manager	15	Manufacturer
Panel 9	Operation Manager	20	Manufacturer
Panel 10	Quantity Surveyor	25	Academia

Table 1 shows expert panels who are involved in this study. The selection of expert panels includes a range of fields, so they can express their thoughts on IBS and M&A from different points of view. The study intends to incorporate opinions on the current state of M&A adoption in IBS approach-based contribution of the expert panel from various fields such as manufacturer, contractor, academia, industry player. Through this method of data collection, this study can help fulfil the government's agendas and mission within the aspect of M&A in IBS. The next topic will elaborate upon the procedure carried out during the interview sessions.

In this study, interview sessions utilise the Delphi Method, which is categorised as a decision-making technique for expert panels, to assist them during the interview sessions. There are many decision-making techniques employing expert panels that can be applied through interviews. All of these techniques have their unique approach and design such as social choice theory, creative problem-solving process, nominal group technique, Delphi method as well as Voting System. The understanding of each technique is very important because it cannot be applied in every case. Basically, these techniques require expertise, goals, and duration of time. However, Horn (2006), insisted that the capability of experts to make decision immensely influences a discussion result. This is due to their

limitation in overcoming systematic mistakes that normally take place during a discussion based on the current states of the minds of the experts or the perceptions of the experts leading to an outcome of a discussion.

Most of these decision-making techniques in interviews introduce psychology, human judgment or decision making, which is very difficult to monitor (Josephson Institute of Ethics, 2005). To avoid these problems, the selection of a suitable decision-making technique is very crucial. This study reveals that Delphi Method is suitable to develop and validate current issues of M&A. Delphi studies are procedures that include the preparation, an interview in two or more rounds and some resolutions and application or implementation when the interview is finished (Cuhls, 2003). In order to apply the Delphi Method in this study, an anonymous interview is done to each panel member respectively. Ten expert panel members have been selected to be involved in the interview session. Figure 2 shows the organisation of a Delphi Method in this interview.



**Figure 2: Organisation of a Delphi Method in developing and validation current issues on the implementation of M&A by experts**

Table 2 shows the comment of the respondents on the current state of mechanisation and automation in IBS approach from the preliminary survey. According to Abedi (2011), Kamal *et al.* (2009) and CIDB (2015) the movement of IBS has been on the right track for moving forward in order to deal with a growing demand of affordable housing and to develop the country. This was supported by the interviewee (Table 2) that M&A is important to the implementation in IBS approach.

**Table 2: Current state of Mechanisation and Automation (M&A) in IBS approach**

No	Respondent	Ref	Perception and understanding of the current state of M&A in IBS approach
1	Operation Manager	R1	The current issue of M&A are very complex and there is limited understanding and it is also reduced in <i>dependency on foreign labour</i> , the <i>technology are complex</i> , <i>high capital cost</i> , <i>lack of incentives</i> of the government and policy
2	Senior Manager	R2	The implementation of M&A has its own uniqueness and is very subjective. The dependency on labour are the major issues in IBS, <i>high capital cost</i> , the <i>technology are complex</i> , <i>incentive by government</i> and <i>availability of the technology</i>
3	Engineer	R3	IBS is still new in Malaysia and it is not fully utilised by contractors. Nevertheless, M&A in IBS will take more effort of reducing in <i>dependency on foreign labour</i> , <i>high capital costs</i> associated with M&A and the <i>technology are complex</i> and <i>high tech and expensive</i> . the <i>availability of the technology are the characteristic of M&amp;A</i>
4	Quantity Surveyor	R4	The current state of M&A are to reduce the dependency on foreign labour and cost (high capital), availability of the technology and resistance to change by client.
5	Project Manager	R5	M&A are less dependency on foreign labour, high capital cost, availability of the technology in Malaysia, the government incentive and policy, fragmented industry and difficulty in maintain and operate the technology, resistance to change by client.
6	Manager	R6	The M&A issues are to reduce the dependency on foreign labour, cost (high capital cost, maintenance), incentive & policy by government, lack of familiarity of used at ground level and the technology are complex
7	General Manager	R7	The implementation of M&A has to reduced <i>dependency on foreign labour</i> and <i>cost (high capital cost)</i> and <i>incentive</i> by the government.
8	Senior Manager	R8	Current issue of M&A are very important in IBS approach to <i>reduce the foreign labour</i> , the issues of the <i>cost in the capital cost and maintenance cost</i> , the government are not given the <i>incentive and the policy</i> are very strict. Besides <i>the technology are very expensive</i> and the <i>availability</i> . It is also difficulty in <i>maintaining the plant</i> and also <i>the fragmented the industry</i> .
9	Operation Manager	R9	<i>Difficulty Maintenance</i> the plant and the <i>availability of the technology</i> are very important. The technology also <i>expensive</i> , <i>complex</i> and lack of <i>incentive</i> by the government to helps the player. To certain our company is reluctant to integrate M&A unless forced by the government.
10	Quantity Surveyor	R1 0	The current issue of M&A are to <i>reduce the foreign labour</i> and <i>high capital cost</i> , the <i>technology are complex</i> and <i>lack of incentive</i> by the government to help the industry players.

Referring to the Table 2, a total of 10 experts (Round 1) were invited to participate in this Delphi study which covers various fields. However, only nine (9) of these experts (Round 2) remained until round 3, or 90% of them. This resulted in only nine (9) permanent experts in the panel who are directly involved with this Delphi study. The majority of respondents commented on the positive impact on the



current state of mechanisation and automation in IBS approach even though respondents (R9) states that their company would not integrate mechanisation and automation unless there was government legislation forcing the adoption of IBS in construction. According to Kamar *et al.* (2014) the new circular by the Ministry of Finance (MOF) emphasized on the full utilization of IBS for all government's projects. The circular emphasized that the use of IBS components in government projects should not be less than 70%.

**Table 3: Current state of Mechanisation and Automation (M&A)**

Current state	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	Freq	(%)
Less dependency on foreign labour	√	√	√	√	√	√	√	√	√	√	10	100
High capital cost	√	√	√	√	√	√	√	√	√		9	90.0
Lack of incentive and government policy	√	√	√	√	√	√	√	√			8	88.9
The technologies are complex, high tech and expensive	√	√	√		√	√	√		√		7	77.8
The Availability of technology		√	√	√	√				√	√	6	66.7
Resistance to change by clients				√	√			√	√	√	5	55.5
Fragmented industry					√			√	√	√	4	44.4
Difficulty in maintaining and upgrading the technology					√				√	√	3	33.3
High Maintenance Cost						√		√			2	22.2
Lack of familiarity of use at ground level						√					1	11.1

Table 3 lists ten (10) most significant driving factors in promoting the adoption of sustainable construction practices mentioned by the respondents during the preliminary survey. These are; reduction in depending on foreign labour; high capital cost; lack of incentive; the technologies are complex, high tech and expensive; availability of technology; resistance to change by client; fragmented industry; difficulty in maintaining and upgrading the technology; maintenance cost; and lack of familiarity of use at ground level. Among others less dependency on foreign labour is selected by most of the respondents.

Regardless, a total of nine experts were adequate to meet the requirements to run this Delphi study (Okoli & Pawlowski, 2004). Nevertheless, one respondent failed to proceed with the second-round assessment for some reason. Each result that was achieved will be collected, concluded, improved and later given back to the expert panel for them to either give their consent, present their new opinion regarding the matter or remain with their original opinion.

In round 2, the respondents put forwards that knowledge is important in the current state of mechanisation and automation in IBS approach. The reason is due to implementation of mechanisation and automation in IBS approach that will be requires on advanced technology is vital to move forward the construction industry. Besides, advanced technology should be used to accelerate the integration of sustainability in IBS. According to CIDB (2011), the government also encouraged the use of technology of M&A in the construction process. The results in Table 3 implied that more efforts are needed and should be directed towards the M&A in IBS approach. This is in line with Zairul. M. (2021). construction knowledge is very important to avoid the damages caused by unskilled workers that can affect the adoption of mechanisation and automation. Therefore, it is the time for the government to support mechanization and automation in the Industrial Revolution IR4.0, and encourage the developers and contractors in producing skilled workers so that participation in IBS projects can move forwards.

In round 3 is to validate the findings. As for less dependency on foreign labour factors, ten out of ten (100%) respondents highlighted the implemented mechanisation and automation as one the current state of M&A in IBS approach. As described by one of the respondents during semi-structured interview that the important of less dependency on foreign labour is because it can improve the economic development. This is in line with Mohammad *et al.* (2018) that put forward the less dependency on foreign labour as one of the strategies to move forwards and sustainable the IBS development.

Based on the findings, more than 88.9% of respondents agree that the high capital cost as one of the current states of M&A in IBS approach. During the semi structured interview, the respondents emphasize that the construction industry players need to change the mind set at the first place from conventional to IBS. He believed that the initial investment for the heavy machinery and equipment in the production system is repaid when the savings are achieved over the whole life of IBS products. This in line with Chen *et al.* (2010b) and Tam *et al.* (2007) that put forward the higher initial cost can be reduced after long term construction.

The lack of incentive and government policy, more than 58.1% (seven out of ten) of the respondents highlight that the government should play bigger roles in promoting IBS by giving financial support. In terms of financial support, majority of respondents suggest that government support and promoting is important in term of fund and tax incentive in the first place to encourage industry player to implement M&A in IBS approach. The given incentive can be machansim to motivate the construction sector in the industry. The results incline with Hamid *et al.* (2008) the incentive to construction projects that utilized IBS components in 50% of the building works, will received an exemption of construction levy (CIDB levy -0.125 % of total cost of the project according to Article 520). Furthermore, the government will establish new policy to reduce 50% of current 320,000 foreign workers registered with the sectors and CIDB has been allocated RM 100 million to train skilled workers in IBS (BERNAMA, 2009). This is inline with Yahya (2020) that put forward the more scheme by government are encourage the use of automation with solving the critical barriers face by industry player, most of the developers would consider.

Furthermore, five out of nine (55.5%) of respondents highlighted that the technology in IBS are very complex, high tech and expensive. As described by one of the respondents during the semi structured interview that the major issues in the implementing M&A is because of the technology are very complex, high tech and very expensive. This in line with Yunus (2014) that put forward the investment in new technology normally will involve a huge amount of financial and human resources. Hence, human resource issues further confirm the lack of IBS adoption among contractors due to the inadequate skilled workforce to operate machines and automated equipment on site (Alawag. *et al.* 2019). Expensive equipment and machines need to be operated by skilled workers to avoid inefficiency and technical problems.

The availability of the technology issue, five out of nine (55.5%) of respondents believe that the availability of the technology are the main issues in the implementation of the M&A in IBS approach. During semi structure interviews, the respondents emphasized that the practitioners' in industry are still moderate in terms of their technology readiness. To increase their readiness, it is important to provide sufficient equipment and that skilled personnel are available for implementing sustainable IBS technology.

In addition, resistance to change by the clients, fragmented industry, difficulty in maintaining and upgrading the technology, looking at the high maintenance cost, and the lack of familiarity of use at the ground level are the other issues that influence on the implementation of M&A in IBS approach.

As for the main survey, these ten most significant issues of the implementation of M&A in IBS approach are very important and the major current state of M&A in IBS approach. They were also concerned about the foreign labour involved in the IBS project. In line with Kadir *et al.* (2006) the labour usage has been identified as the most critical element in the construction industry due to a severe shortage of local workers. Nevertheless, the setting up of an IBS manufacturing factory requires a strong financial palnning to ensure that the development can be sustained for a longer period.

#### 4. Conclusion

10 expert players' in Klang Valley have been interviewed, representing a 100 per cent response rate. The targeted respondents in this study include top management levels in the organization; with experience and currently handling the IBS project. The study indicates the most significant issues of the implementation of M&A in IBS approach are very important and the major current state of M&S in IBS approach. The result shows most of current state of M&A will help to increase the construction players' understanding and help them to be prepared in handling the IBS project. The current state of M&A will act as a basis and become helpful for construction players who implement M&A in IBS construction to determine the difficulty and enable them to avoid potential risks. It is anticipated that the findings from this study will create awareness, assist construction players to understand issues arise in the implementation of M&A in IBS construction, increase the chances for successful implementation and serve as a guideline for future planning. For the better adaptation of these technologies, the construction industry must become more structured and controlled. Implementation of M&A can result in producing buildings more efficiently concerning cost, time, and quality.

There is still huge space for improvement for M&A to cater for the needs of construction players and projects especially in the context of sustainability in IBS construction. Malaysia's construction industry should speed up its pace in incorporating more technology and direct the path towards an eco-friendly industry to encourage more sustainability in IBS construction. Through this study, it is hoped to give insight to the construction industry players into M&A concerning current state in IBS construction to move forwards.

#### Acknowledgement

The authors would like to thank the Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia for its support.

#### References

- Alawag, A.M., Yunus, R., Handan, R., Kasim, N. (2019). Determining factors for enhanced skilled worker requirements in IBS construction projects in Malaysia. IOP Conference series; earth and environmental science.220. 19, 012048. DOI: 10.1088/1755-1315/220/1/012048.
- Alexander, W. F., & Serfass, R. W. (1999). *Futuring tools for strategic quality planning in education*. Milwaukee, WI: American Society For Quality: Quality Press.
- Azman, M.N.A & Ahmad, M.S.S. (2010). Perspective of Malaysian Industrialised Building System on The Modern Method of Construction. The 11th Asia Pacific Industrialized Engineering and Management Systems Conference.
- Bernama (2006). Local Construction Industry Urged to Use, IBS Business, National News Agency, Malaysia
- Chen, Y., Okudan, G.E. & Riley, D.R. (2010). Sustainable performance criteria for construction method selection in concrete buildings. *Automation in construction*. 19(2): pp.235-244.
- CIMP (2007). *Construction Industry Master Plan 2006-2015*. Construction Industry Development Board, Kuala Lumpur.
- Clifford, N., Cope, M., Gillespie, T., & French, S. (Eds.) (2016). *Key methods in geography*. Sage
- Construction Industry Development Board CIDB. (2011). CIDB (Amendment) (Act A1407), Construction Industry Development Board (CIDB), Kuala Lumpur
- Construction Industry Development Board CIDB. (2012). *Construction Quarterly Statistical Bulletin*. Kuala Lumpur, CIDB Malaysia.
- Construction Industry Development Board (CIDB). (2015). *Construction Industry Transformation Programme 2016-2020 (CITP)*. Kuala Lumpur: Construction Industry Development Board (CIDB) Malaysia.
- Creswell, J. (2009). *Qualitative Inquiry and Research Design: Choosing among Five Approaches*. Thousand Oaks, California: Sage Publications.

- Cuhls, K. (2003). Delphi method. *Fraunhofer Institute for Systems and Innovation Research*. Germany.
- Egan, J., (1998) Rethinking construction, report of the construction task force on the scope for improving the quality and efficiency of the UK construction industry, the Department of the Environment, Transport and the Regions, London.
- Hamid, Z. A., & Kamar, K. A. M. (2012). Aspects of off-site manufacturing application towards sustainable construction in Malaysia. *Construction Innovation: Information, Process, Management*, 12(1), 4–10. <http://doi.org/10.1108/14714171211204185>
- Hansson, B. (1996). Precast concrete box units – a case study. In: *The Organization and Management of Construction: Shaping Theory and Practice (Vol II)*, E&F Spoon, 1996. 4p.
- Harold, A. L., & Murray, T. (1975). *The Delphi Method: Techniques and Applications*. Mass: Adison Wesley.
- Horn, C. (2006). How experience affects perception in Expert Decision-Making.
- Idoro, G.I., (2011). Effect of mechanisation on occupational health and safety performance in the Nigerian construction industry. *Journal of Construction in Developing countries*, 16 (2): pp27–45.
- Ismail, H. Akash, Z. A., Nagapan, S., Khamis, A. and Saharani, M. (2019). An empirical study on benefits and future expectation of (IBS) applications in Melaka construction firm. IOP Conference Series Josephson Institute of Ethics (2005). Retrieved May 20, 2012 from <http://www.josephsoninstitute.org/>.
- Kamar, K. A. M., Alshawi, M. and Hamid, Z. (2009). Barriers to industrialized building system (IBS): the case of Malaysia. Paper Proceedings in BuHu 9th International Postgraduate Research Conference (IPGRC) Salford, United Kingdom.
- Kamar, K. A. M., Hamis, Z. A., & Dzulkalnine, N. (2012). Industrialised building system (IBS) construction: measuring the perception of contractors in Malaysia.
- Kamaruddin, S. S., Mohammad, M. F., Mahbub, R., & Ahmad, K. (2013). Mechanisation and Automation of the IBS Construction Approach: A Malaysian Experience. *Procedia - Social and Behavioural Sciences*, 105, 106–114. <http://doi.org/10.1016/j.sbspro.2013.11.012>
- Knutson, C. J. S. K., Fiori, C. M., & Mayo, E. E., (2007). *Construction Management Fundamentals*. McGraw-Hill, New York.
- Leech, B. L. (2002). Asking questions: techniques for semi structured interviews. *PS: Political Science & Politics*, 35(4), 665-668.
- Lessing, J., (2006). *Industrialised House-Building - Concept and Processes*, PhD Thesis Department of Construction Sciences Lund Institute of Technology, Sweden.
- Mahbub, R. (2012). Readiness of a Developing Nation in Implementing Automation and Robotics Technologies in Construction: A Case Study of Malaysia, *Civil Engineering and Architecture*, Vol. 6, No. 7.
- Mahbub, R. (2008). An investigation into the barriers to automation and robotics technologies in the construction industry. PhD Thesis.
- Mahbub, R. & Humphreys, M. (2005), “An Investigation Into the Barriers to Automation and Robotics in Construction”, Proceedings of COBRA/AUBEA/CIB/RICS QUT Research Week International Conference, Brisbane: 215-220.
- Mohamed, M. R., Mohammad, M. F., Mahbub, R., Ramli, M. A., & Jamal, K. A. A. (2018). The Issues and Challenges of Small and Medium-Sized Contractors in Adopting Industrialised Building System. *International Journal of Engineering & Technology*, 7(3.25), 432–436.
- Mydin, M.A.O, Sani, N. Md and Taib, M. (2014). Industrialised Building System in Malaysia: A Review. MATEC Web of conferences
- Navon, R. (1996). Teaching Automation as Part of the Construction Curriculum. Elsevier *Automation in Construction*.
- Nawi, M. N. M. L., A. Arif, M. (2014). The IBS Barriers in the Malaysian Construction Industry: A study in Construction Supply Chain Perspective. Papers and PostGraduate Papers from The Special Track Held at CIB World Building Congress 77–92.
- Nawi, M., & Lee, A. (2013). Fragmentation Issue in Malaysia Industrialized Building System (IBS) Project. *Journal of Engineering Science and Technology* 9 (1), 97-106. Retrieved from [http://jestec.taylors.edu.my/Vol 9 Issue 1 February 14/Volume \(9\) Issue \(1\) 097-106.pdf](http://jestec.taylors.edu.my/Vol 9 Issue 1 February 14/Volume (9) Issue (1) 097-106.pdf)
- Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & Management*, 42(1): pp15-29.
- Parker, N. R., Salcudean, S. E., & Lawrence, P. D. (1993). Application of force feedback to heavy duty hydraulic machines. *Proc. Int. Conf. on Robotics and Automation*.
- Richard, R. B. (2005). Industrialised Building Systems: Reproduction Before Automation And Robotics, *Automation In Construction*, 14, pp442– 451.
- Sadique Ashna Sadique1 and Gangadhar Mahesh. (2016). Barriers to Mechanization and Automation in Indian
- Smith, J.A. (1995). Semi-structured interviewing and qualitative analysis. In Smith, J.A., Harre', R. and Van Langenhovem, L. (eds) *Rethinking Methods in Psychology*. London: Sage.
- Tam, V. W. Y., Tam, C. M., Zeng, S. X., & Ng, W. C. Y. (2007). Towards adoption of prefabrication in construction. *Building and Environment*, 42(10), 3642– 3654. <http://doi.org/10.1016/j.buildenv.2006.10.003>

- Warszawski, A. (1999). Industrialised and Automated Building System, Technion Israel Institute of Technology.
- Yunus, R., & Yang, J. (2014). Improving ecological performance of industrialized building systems in Malaysia. *Construction Management and Economics*, 32(1–2), 183–195. <http://doi.org/10.1080/01446193.2013.825373>
- Yahya, N.F.A.N, Mahdzir. M and Jie. J.H.Y. (2020). The advantage and Barriers of Automation in Malaysia Construction Industry. International Conference on Innovation and Technopreneurship 2020. *Inti Journal*. Vol.2020:032.
- Yue, C. S., (2011). Free Flow of Skilled Labor in the AEC, Singapore Institute of International Affairs, Singapore
- Yusof, F. (2017). IBS to be compulsory for construction Project in 2018. IBS Digest News. Issue 1 2017. Pg 26.
- Zarul, M. (2021). Opening the pandora’s box of issues in the Industrialised Building System (IBS) in Malaysia: A thematic review. *Journal of Applied Science and Engineering*, ol.25, no 2. Page 297-310.