

Opening the Pandora Box of Issues in the Industrialized Building System in Malaysia: A Thematic Review

Mohd Zairul

Department of Architecture, Faculty of Design and Architecture, UPM Serdang

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Abstract

Under the Malaysian construction industry transformation programme (CITP) 2016-2020, IBS has been proposed as one of the alternative solutions to replace conventional construction. A lot of IBS advantages have been documented and discovered since its first implementation in the '90s. However, there is a lack of review paper that deliberates on IBS issues in the literature. Hence, this paper adopts a thematic review based on the issues captured in the IBS publications from 2012 till 2019. The strategy of the article was investigated via an extensive review paper on IBS and analysed using thematic analysis by ATLAS.ti 8 software. The findings from the code-to-document report in ATLAS.ti 8 found that the pattern and trends on IBS highlighted several issues in the literature. The outcomes benefit the future research direction and identify the gap for future solutions in the IBS related projects in Malaysia.

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1. Introduction

Under the Malaysian construction industry transformation programme (CITP) 2016-2020, IBS has been proposed as an alternative solution to replace conventional construction. A lot of advantages of IBS has been documented and discovered since its first implementation in the '90s. IBS has been proven on paper and in practice to improve the construction delivery and minimize time and cost throughout its lifecycle. Globally, IBS is also known as prefabricated, prefab construction, modern method of construction (MMC) and off-site Construction (Piroozfar, Altan, & Popovic-Larsen, 2012). Under the construction industry transformation programme (CITP) 2016-2020, it is stated that the Malaysian government is accelerating the adoption of IBS through mechanisation and modern practices. There are several definitions of IBS in the practice and the literature, mainly emphasizing on offsite (Jonsson & Rudberg, 2014; Kamar, Zuhairi, Azman, & Ahamad, 2011; Musa, Mohammad, Mahbub, & Yusof, 2018), controlled environment (Rashidi & Ibrahim, 2017; S. Tajul Ariffin, Yunus, Mohammad, & Yaman, 2017; Yunus, Abdullah, Yasin, Masrom, &

Hanipah, 2016), and the most popular term by CIDB is IBS used for a technique of construction where building components are manufactured in a controlled environment, either on-site or off-site, placed and assembled into construction works. Nevertheless, in this article, we define IBS as an innovative process of building component utilizing mass production industrialized system, produced within a controlled environment (on or off-site) which include organized logistic and installation process on-site with systematic planning and management.

Within the Construction Industry Transformation Programme 2016-2020 (CITP) framework on IBS initiative, the government is focusing on the implementation of IBS in the government sector projects as well as extending the usage towards private developers. This, in return, is to provide sustainable value chain in the construction industry in Malaysia. Furthermore, the government is accelerating the adoption of IBS through mechanisation and modern practices. CIDB Malaysia, through IBS Centre, is promoting the usage of IBS to increase productivity and quality at construction sites through various promotion

programmes, training and incentives. The content of IBS (IBS Score) is determined based on the Construction Industry Standard 18 (CIS 18: 2010); either manually, web application or fully automated CAD-based IBS Score calculator. However, the adoption of the IBS system among the practitioners is still low and showing worrying trend (Mohd Fateh, Zakariah, & Ema Ezanee, 2020), and although past literature discussed many issues, there is still no review paper published to deliberate what type of issues plunges the IBS construction in Malaysia. Therefore, the underpinning of this paper is to open the Pandora box of the issues that been discussed in the IBS publications from the year 2012-2019 as through the following research question:

What are the prevalent issues raised in the literature about IBS in Malaysia and its trends from the year 2012 to 2019?

2. Materials and Methods

Table 1: Search strings from Scopus and Mendeley

SCOPUS	"Issues AND "Industrialized building system" AND "Malaysia"	149 results
Mendeley	"Issues" AND "Industrialized building system" AND "Malaysia"	70 results

The literature search was performed in the SCOPUS and Mendeley literature search. The initial search came out with 149 (SCOPUS) and 70 (Mendeley) articles. However, 100 articles were removed due to their premature results and anecdotes or were not discussing IBS issues in Malaysia. Some of the articles were also found incomplete, or the full articles are not accessible, have a broken link and overlapped. Therefore, the final paper to be reviewed down to 60 articles (table 1). The articles were uploaded in the ATLAS.ti 8 as primary documents, and then each paper was grouped into 1) author; 2) issue number; 3) periodical, 4) publisher, 5) volume and 6) year of publication. In doing so, the articles can be analysed according to the year it was published and what is the discussion pattern according to the year. The total articles finalised into the final documents in the ATLAS.ti 8 is 60 documents.

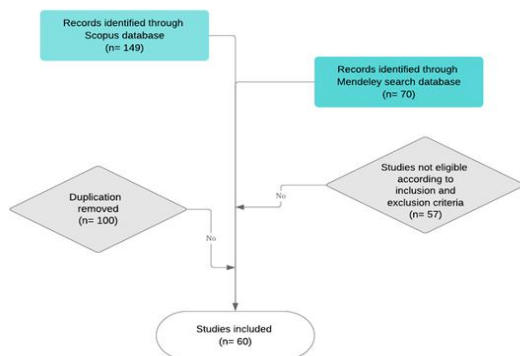


Figure 1: Inclusion and Exclusion criteria in the thematic review

The term thematic review using ATLAS.ti as the tool as being introduced by Zairul (2020) is implemented because the method of this study applies thematic analysis procedure in a literature review. Clarke & Braun (2013) define thematic analysis is a process of identifying the pattern and construct themes over thorough reading on the subject. The following step is to identify the pattern and construct category to understand the trend of IBS publication in the country. The tenets of the research are to analyse and interpret the findings for the recommendation of future research in IBS subject. The selection of literature was performed according to several selection criteria: 1) publication from 2012- 2019, 2) Have at least keyword(s) IBS or Industrialized Building System or Prefabricated, 3) Focusing on IBS issues in Malaysia. The decision to limit the country of origin was made to help define the issues and problems of IBS in the Malaysia context.

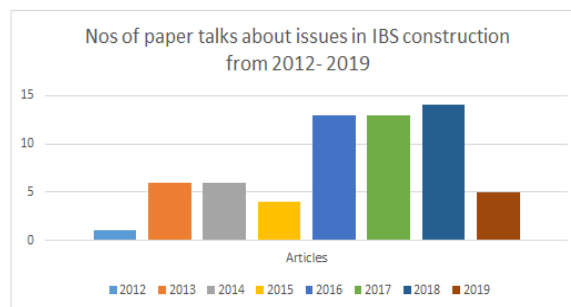


Figure 2: Paper breakdown according to the year of publication

3. Results and Discussions

The main conclusions of the thematic review are reported in this section. As can be seen from the figure 2, a word cloud from the 60 documents captured 'IBS' with 4594 times, while 'construction' in the second rank with 4383 mentions and third mentions is term 'building' with 1554 times. Based on the thematic analysis of the selected articles, the following discussion is the category that we captured from the 60 articles.



Figure 3: Word cloud generated from 60 articles

Table 3: Type of issues discussed in the literature

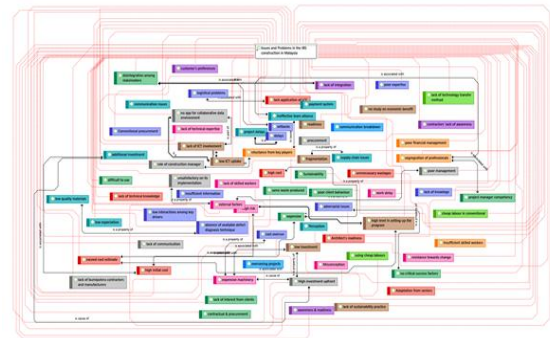
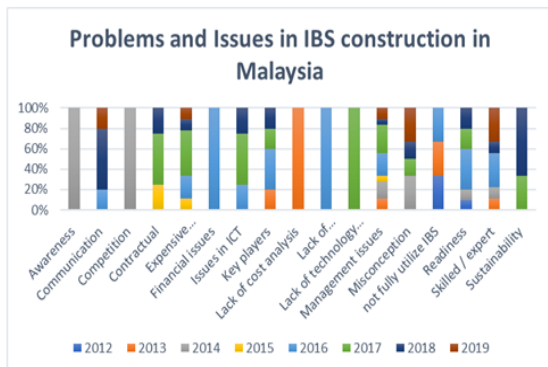


Figure 4: Network diagram on the issues and Problems found in the publication from 2012-2019

In the first round, the initial coding resulted to 74 codings (table 2) and later were categorized into 6 main categories; 1) Financial issues, 2) Human resource issues, 3) Management issues; 4) readiness issues, 5) technology-related issues and 6) technology issues. The process to cluster the initial coding into the category is common in a thematic review to categorize a common code together under a similar cluster. However, it is also common for a code to belongs to several categories (code group). There are several issues discussed in the literature that belongs to a similar cluster/category. From table 2 we can see the trend is rising by year but reduce in 2019 partly due to the review was done in the middle of the year 2019.

Table 2: Initial coding on issues in IBS

	2012	2013	2014	2015	2016	2017	2018	2019
● absence of available defect diagnosis technique					1			
● additional investment							1	
● adversarial issues			1					
● Architect's readiness					1			
● awareness & readiness					1		1	
● cheap labour in conventional			1					
● communication breakdown							1	
● communication issues							1	
● contractors' lack of awareness			1					
● contractual & procurement						2		
● Conventional procurement							1	
● cost overrun						1		
● customer's preferences			2					
● delays						2		
● difficult to use		1	1					

● disintegration among stakeholders			1	
● exceed cost estimate			1	
● expensive				1
● expensive machinery			1	
● external factors			1	
● fragmentation	1	1		2
● high cost				1
● high initial cost			1	
● High investment upfront				1
● high level in setting up the program				1
● high risk				1
● ineffective team alliance			1	
● insufficient information				1
● insufficient skilled workers				1
● lack application of LCC				1
● lack of Bumiputera contractors and manufacturers			1	
● lack of communication			1	1
● lack of ICT involvement				2
● lack of integration				1
● lack of interest from clients	1			
● lack of knowledge				1 1
● lack of skilled workers				1
● lack of sustainability practice				1
● lack of technical expertise			1	
● lack of technical knowledge			1	
● lack of technology transfer method				1
● logistical problems				1
● low expectation				1
● low ICT uptake			1	
● low interactions among key drivers				1
● low investment				1
● low-quality materials		1		1 1
● Misconception	1		1	1
● no app for the collaborative data environment				1
● no critical success factors			1	

● no study on the economic benefit	1				
● overseeing projects					1
● payment system		1			
● Perception	1			1	1
● poor client behaviour			1		
● poor expertise			1		
● poor financial management			1		
● poor management	1				
● procurement		1			
● project delays	1				
● project manager competency					1
● readiness			1	1	
● reluctance from key players			1		
● resistance towards change			1	1	
● role of construction manager	1				
● same waste produced					1
● segregation of professionals				1	
● setbacks				1	
● supply chain issues	1				1
● Sustainability					1
● unnecessary wastages				1	
● unsatisfactory on its implementation			1		
● using cheap labours					1
● work delay					1

Table 3: The tabulation of authors discussion on issues about IBS construction according to theme

	Financial issues	Human resource issues	Management issues	Readiness issues	Technology-related issues	Sustainability issues
(Abas, Hanafi, & Ibrahim, 2013)				/		
(Adnan, Einur Azrin Baharuddin, Arzlee Hassan, Aisyah Asyikin Mahat, & Khalidah Kaharuddin, 2019a)	/			/		
(Ahmad Bari, Mohd Yusuff, Ismail, & Jaapar, 2018)						/
(Azman, Ramli, & Zawawi, 2018)		/	/			
(Azuan et al., 2016)				/		
(Baharuddin, Bahardin, Zaidi, & Yusof, 2019)				/		
(Din et al., 2017)	/					
(Soon Ern, Kasim, & Chen, 2016)					/	
(Fauzi, Hasim, Awang, Mohd Ridzuan, & Yunus, 2018)			/	/		
(Fitri Othman, Wan Muhammad, Abd Hadi, & Azman, 2017)	/		/			
(Hadi, Muhamad, & Othman, 2017)			/	/		
(Hanafi, Abas, Ibrahim, & Abdullah, 2016)				/		
(Haron, Abdul-Rahman, Wang, & Wood, 2014)			/	/		

(Z.-A. Ismail et al., 2016)	/		
(Z. A. Bin Ismail, 2018)			/
(I. Iaili Jabar, Ismail, Aziz, & Janipha, 2013)	/		
(I. L. Jabar, Ismail, & Aziz, 2018)	/		
(I. Iaili Jabar, Ismail, & Abdul Aziz, 2018)			/
(Musa, Mohammad, Mahbub, & Yusof, 2014)	/		
(Kamaruddin, Mohammad, Mahbub, & Ahmad, 2013)	/		
(Kassim, Abdullah, & Udin, 2014)	/		
(Lim et al., 2017)		/	/
(Liyana Binti Tajul Ariffin et al., 2018)	/		
(Md. Ali, Haslinda Abas, Mohd Affandi, & Ain Abas, 2018)	/		
(Mohammad, Shukor, Mahbub, & Halil, 2014)	/		
(Mohammad, Baharin, Musa, & Yusof, 2016)	/	/	
(Mohd Affendi Ahmad Pozin, Mohd Nasrun Mohd Nawil, Angela Lee, Mazri Yaakob, 2018)	/		
(Mohd Amin et al., 2017)	/		
(Mohd Fateh & Mohammad, 2017)	/		
(Mohd Fateh, Mohammad, Abd Shukor, et al., 2017)	/		
(Mohd Nasrun Mohd Nawil, Md Azree Othuman Mydin, Ahmed Mohammed Kamaruddeen, Angela Lee, 2015)	/		
(Mohsen, Yunus, Handan, Kasim, & Hussain, 2019)	/		
(Muhaidin & Chan, 2018)			/
(Muhammad et al., 2016)			/
(Musa, Mohammad, Yusof, & Ahmad, 2016)			/
(Musa et al., 2018)			/
(M. Mydin, Sani, & Taib, 2014)			/
(M. A. . Mydin, Phius, Sani, & Tawil, 2014)	/		/
(Nasir, Nawil, Rahim, Bahaudin, & Tapa, 2016)	/	/	/
(MNM Nawil, Anuar, & Lee, 2013)			/
(MNM Nawil & Lee, 2013)	/	/	
(Mohd Nasrun Mohd Nawil et al., 2015)	/	/	
(Mohd Nawil, Azman, Osman, Radzuan, & Yaakob, 2016)	/		
(M.N.M. Nawil, Lee, Mydin, Osman, & Rofie, 2018)	/		
(Noor, Yunus, Abdullah, Nagapan, & Mazlan, 2018)	/		
(Rahim, Hamid, Zen, Ismail, & Kamar, 2012)			
(Rashidi & Ibrahim, 2017)			/
(Razak & Awang, 2014)	/		
(Saikah, Kasim, Zainal, Sarpin, & Rahim, 2017)	/		
(Shamsuddin et al., 2017)	/	/	
(Shamsuddin, Zakaria, & Mohamed, 2013)	/		
(Shu Chi, Marsono, & Md. Tap, 2016)	/	/	
(Soon Ern, Kasim, Abd Hamid, & Kai Chen, 2017)			/
(Soon Ern, Kasim, Nasid Masrom, & Kai Chen, 2017)			/
(S. Tajul Ariffin et al., 2017)	/		
(H. L. Tajul Ariffin, Mohd, Mustaffa, Bandi, & Mei Chee, 2019)	/	/	
(Waris, Liew, Faris, & Idrus, 2015)	/		
(Yunus, Abdullah, et al., 2016)	/	/	/

(Yunus, Suratkon, Wimala, Hamid, & Mohd Noor, 2016)

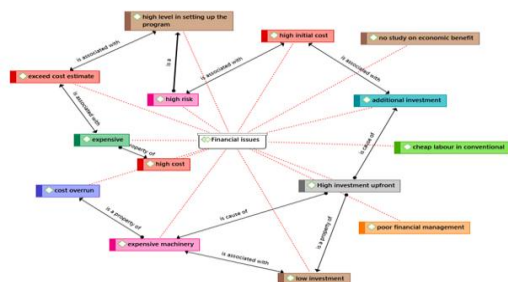
(Yusof, Musa, Samsudin, Mohammad, & Baharuddin, 2016)



3.1 Financial Issues

Several papers discussed on the financial issues in the IBS, several reasons on the lack of participation were highlighted such as the challenges in business operations and management on IBS projects (Adnan et al., 2019a). The financial issues are also associated with cheap labours from the nearby regions has caused the contractors to prefer conventional way compared to IBS system (Razak & Awang, 2014). Several issues reported the disadvantages of the system while being over cost, cause more delays and resulted to high maintenance, which partly caused by the lack of proper coordination on-site (Fitri Othman et al., 2017). However, the issues mentioned in the literature did not suggest a case study done on existing IBS projects. This line of reports extends to the distending price when adopting the system as reported by Shu Chi et al., (2016).

Several authors highlighted the cost of a comparison made by the contractors, which slightly higher from the reasonable price for about 40% difference (S. Tajul Ariffin et al., 2017). This line of arguments shared by Waris et al., (2015) on the high initial investment if adopting IBS especially towards smaller construction companies (Saikah, Kasim, Zainal, Sarpin, Rahim, et al., 2017). Hence, the image of IBS as a system which reduced the construction price was tainted by such remarks reported in the literature. Therefore, future research needs to report on how the IBS system might help in terms of reducing the overall prices and produce savings towards the contractor and the developer. Nevertheless, the studies were not reporting the type of contractors that involved with the project as well the kind of business they are operating.



3.2 Human resource issues

Malaysia, like any other countries in the developing nations, is facing a lack of skilled workers to operate mechanisation and automation in the construction process (Md. Ali et al., 2018). This skilled worker is vital in the IBS construction when recently the development is talking towards moving into the Industrial Revolution 4.0. The human resource issues further confirmed the lack of adoption among the contractors are caused by a lack of skilled workforce to operate machines and automation equipment on site (Mohsen et al., 2019). Further, some of the material requires high technical skills and caused the additional cost to the construction which the contractor try to avoid (Mohammad et al., 2016). In comparison, IBS can be easily practised by the developed countries since they have high access to high skilled workers with good pay (Yunus, Abdullah, et al., 2016).

Employing unskilled labours on-site has caused several problems to the IBS system as well, especially in terms of the jointing and installation (Azman et al., 2018). This problems has caused severe defects on the construction and further triggered more financial implications towards the contractors during the defects liability period (Z.-A. Ismail et al., 2016). The damages caused by unskilled workers can affect the adoption of IBS in the future. However, the needs for technology transfer and investment on skilled workers were one of the factors that contributed to the implementation of collaboration between companies using IBS (Adnan, Einur Azrin Baharuddin, Arzlee Hassan, Aisyah Asyikin Mahat, & Khalidah Kaharuddin, 2019b). The investment in a good skill worker was also proven to ensure the projects will be completed with high quality (Mohsen et al., 2019). Further, Mohsen et al. (2019) concluded in his research that employing skilled workers for IBS projects are important factors to ensure the success of the project. In a similar statement, skilled workers are especially important in the work process, and therefore continuous training is crucial to avoid risks and sub-standard issues (Lu, Chen, Xue, & Pan, 2018; Mohd Nasrun Mohd Nawi, Abdullah, Ramli, Zalazilah, & Bahauddin, 2018).



Hence, it is about time for the government to support mechanisation and automation in the Industrial Revolution IR 4.0 and to encourage developers and contractors to increase skilled workers in their company to multiply their participation in the IBS projects.

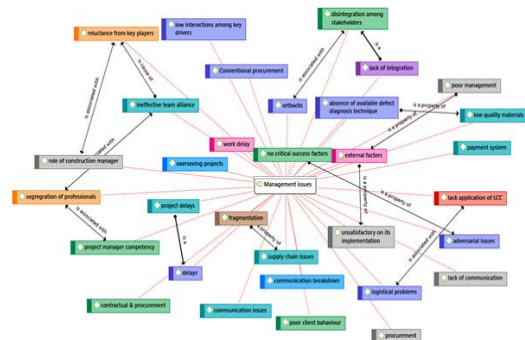
3.3 Management issues

The nature of managing IBS projects have different complexity compared to the conventional ones. Moreover, IBS projects deal with adversarial issues (I. L. Jabar et al., 2018). The complexity of the project thus requires a competent project manager to ensure the program will follow as per schedule (Gido & Clements, 2011). Nevertheless, the complexity of management differs from one project to another. The risk that involves in the IBS projects has always associated with high initial investment and unknown return of investment (Shu Chi et al., 2016). Lack of research on the project manager competency has also resulted in examining the required skill in the IBS related project (I. Iaili Jabar et al., 2013). Furthermore, Rashidi & Ibrahim, (2017) highlighted that although the contractor seems to obtained IBS contract, the delivery still using the conventional method.

It has been apparent that the management decisions are also dealt with risk management, which the construction projects is proven riskier than any other industries in the world (Taofeeq, Adeleke, & Lee, 2020). It was also reported that the construction industry in Malaysia is not well equipped with risk management strategy caused by lack of expertise (Taofeeq et al., 2020). Unknown risk in IBS projects can lead to distinct risks and result in projecting failure (Goh, Goh, Bilal, Toh, & Mohamed, 2019). Further, Goh et al., (2019) highlighted several risks type which includes, economic risks, risk avoidance and risk reduction. In today's world that equipped with ICT as a tool, lack of readiness towards the business transformation in the technology-oriented was also caused by management ineffectiveness (Pozin, Nawi, Mydin, Riazi, & Imran, 2019). Further, a lack of integration that caused disorder in the IBS projects was also reported as one of the issues found on site (Z.-A. Ismail, 2018). Nevertheless, the advent of technology in ICT means nothing when the industry has low coordination in industrialized technologies such as modularization, automation and mechanization (Xue, Zhang, Wang, Skitmore, & Wang, 2018).

Therefore, the benefits of IBS unable to be reaped due to old ways and strategy that still practised the conventional method in IBS construction management. Supply chain issues that relate to project delivery has caused troubled towards the construction key players that implemented the IBS projects (M.N.M. Nawi et al., 2018). Despite many initiatives from the government to promote the system to the industry, there is still lacking in terms of technical knowledge and technology transfer from abroad. Therefore, it is essential for the top management to understand what is required within IBS

scopes and to promote technology transfer from developed countries for further training and upskills development towards our skills workers.



3.4 Readiness issues

Despite many efforts and incentives from the government, the readiness among the key players is still falling short. According to Adnan et al., (2019b), previous experiences while managing IBS projects were some of the reasons why they decline to take up IBS projects. The low participation further supported by Fauzi et al., (2018), on the readiness issues mostly were from the seniors' managers who did not want to take the risk of adopting a new system. Apart from the contractors, the architects also seemed to hinder the adoption of IBS based on a study from Hanafi et al., (2016). Further, the readiness among the contractors are still low in the case of Malaysia as being reported by Musa et al., (2018). Several authors also mentioned on the readiness from other stakeholders including developers, stakeholders, developers and misconception from the purchaser on IBS product (Azuan et al., 2016; Mohd Affendi Ahmad Pozin, Mohd Nasrun Mohd Nawi, Angela Lee, Mazri Yaakob, 2018; Razak & Awang, 2014). Lack of readiness towards ICT was also part of the discussion by Pozin et al., (2019).

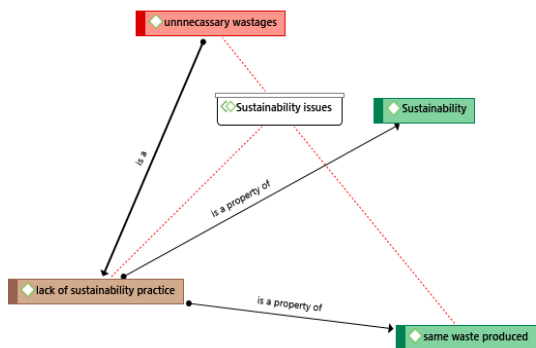
Several authors discussed on the attitude of the stakeholders towards the importance of adoption and discussed the hindering factors towards IBS which highlighted lack of government initiative and training to name a few (Baharuddin et al., 2019). Organizational readiness includes the preparation from the top management in continuous on knowledge improvement, work efficiency and good work coordination (Mohd Nasrun Mohd Nawi et al., 2018). In order to achieve the readiness level, the acceptance must come from the industry (S. Ismail, Mohamad, Zawawi, Nekoioie, & Ismail, 2018), architect's company readiness (Abas et al., 2013), contractor's awareness (Haron et al., 2014) and stakeholder's resistance towards change (Lim et al., 2017). Several authors suggested technology transfer to support the viability of IBS projects (Adnan et al., 2019a; Z.-A. Bin Ismail, 2018; Lim et al., 2017). Therefore, a good strategy is to learn from other countries in handling IBS projects and to consider knowledge transfer from

successful countries such as Japan and Europe in handling IBS projects.



3.5 Sustainability related issues

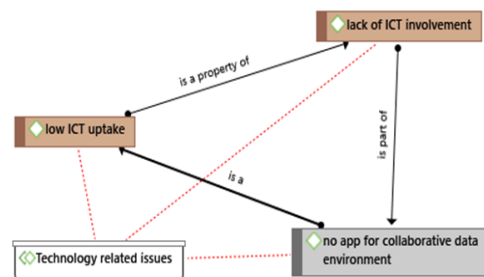
Like any other sustainable goals, IBS projects promised a more sustainable and green construction industry. Due to construction fragmentation in nature, IBS projects gives hope to reduce carbon footprints and to overcome environmental issues associated with conventional construction (Ahmad Bari et al., 2018). The used of precast concrete has been proven to shorten the lead times in the construction, thus contribute to the sustainability of the products (Fitri Othman et al., 2017). However, sustainability efforts by IBS have been challenged by putting higher cost towards the contractor due to the several additional procedures required in the initial cost of the production (Mohd Amin et al., 2017). The challenge of maintaining the sustainable aspects of the IBS construction has always remained the problems by the contractor if the key players do not change the way they work and resistance to change. Therefore, a new work system is needed to put in place to promote a more holistic, sustainable approach for IBS projects in Malaysia.



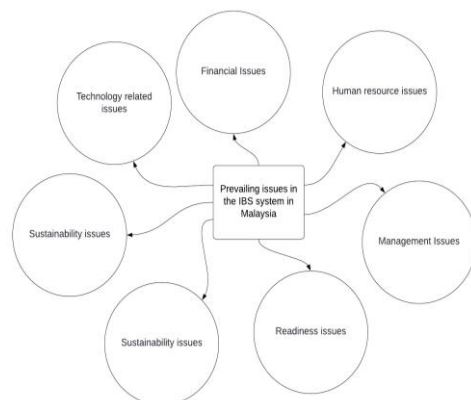
3.6 Technology adoption issues

The construction industry has been promoted to uptake changes to move the industry towards more productivity sector. The government is encouraging the key players in the industry to adopt technology in their construction

workforce to increase its productivity (Mohd Fateh & Mohammad, 2017). Further, key players in the construction industry have been advised to increase the labour's productivity by using advanced construction materials and advance technology through mechanisation and automation system (Mohd Fateh, Mohammad, & Abd Shukor, 2017). However, ICT adoption in the IBS management was not considered as the popular choices among the key players in the industry (Soon Ern et al., 2016). Further, the study proposed that investing in ICT technologies will improve IBS management in the company (Soon Ern, Kasim, Nasid Masrom, et al., 2017). Therefore, it will be beneficial to invent an app and regard technology as the enabler for collaborative data environment of the project management for monitoring IBS works on-site (Z. A. Bin Ismail, 2018).



4. Discussion and future studies



Several issues remain unresolved in the IBS industry in Malaysia. Assuming the latest IBS development in Malaysia on IBS in the construction industry, the number of published articles on IBS will be increased in the future. There are few efforts by researchers to help the industry to move forward. However, very little research was conducted to propose an innovative business model for IBS in the Malaysian context. Therefore, to answer the research question earlier on "What are the prevalent issues raised in the literature about IBS in Malaysia and its trends from the year 2012 to 2019?" On the operational level, most of the issues discussed by the researchers are towards the readiness, although the system has already been introduced in the '70s and popular in the '90s. Moreover, the lack of motivation to

invest in the system also create an imminent threat to the adoption of the system in the construction industry. Several researchers were particularly concerned on the standard form of contract that available in the industry, which is not appropriate to support the IBS system, which is not sequential in nature. Despite several initiatives given by the government, financial issues remain the main problems highlighted in most of the articles, and this is further supported by issues on management and human resource that deals with management decision and skilled workers that also part of financial issues earlier. Sustainability issues and technology work hand in hand in producing full automation, green and sustainable products for the industry.

In summary, the prevailing IBS research highlights several issues that need attention from the key players in the industry. From the top-bottom approach, the government can help to allow more knowledge transfer from international companies that have a proven track record in delivering good IBS system. And from the bottom-up approach, the interest from the shareholders must be equal and work together with researchers to produce innovative IBS system in the future. However, given the arguments in the current IBS, essential works on innovations to support mechanisation, automation and robotic shall be the future of IBS research in the future.

5. Contributions and benefits of study

In a nutshell, this review paper will benefit IBS practitioner in the industry, which includes the government, stakeholders, architect and industry key players. In term of theoretical contribution, this paper adds on IBS issues framework in Malaysia and create potential new research for IBS researcher to use gaps that being discussed in this paper for future studies.

6. Acknowledgements

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