

# INDUSTRIALISED BUILDING SYSTEM (IBS) IN PUBLIC BUILDING CONSTRUCTION: PROFITABILITY ON THE IMPLEMENTATION IN SCHOOL BUILDING

Siti Nur Aishah Mohd Noor <sup>1</sup>  
Shafikah Saharuddin <sup>2</sup>  
Nazirul Syazani Shamsudin <sup>3</sup>  
Noor Anisah Abdullah@Dolah <sup>4</sup>  
Mohd Khairul Amri Ramly <sup>5</sup>  
Nur Fatiha Mohamed Yusof <sup>6</sup>

<sup>1</sup> Department of Built Environment Studies and Technology, Universiti Teknologi MARA, Perak Branch, Seri Iskandar, Perak, Malaysia

Email: sitinuraishahmn@uitm.edu.my

<sup>2</sup> Department of Built Environment Studies and Technology, Universiti Teknologi MARA, Perak Branch, Seri Iskandar, Perak, Malaysia

Email: shafikahsaharuddin@uitm.edu.my

<sup>3</sup> Department of Built Environment Studies and Technology, Universiti Teknologi MARA, Perak Branch, Seri Iskandar, Perak, Malaysia

Email: nazirulyoy@gmail.com

<sup>4</sup> Department of Built Environment Studies and Technology, Universiti Teknologi MARA, Perak Branch, Seri Iskandar, Perak, Malaysia

Email: anisahabdullah@uitm.edu.my

<sup>5</sup> Department of Built Environment Studies and Technology, Universiti Teknologi MARA, Perak Branch, Seri Iskandar, Perak, Malaysia

Email: mkhairulamri@uitm.edu.my

<sup>6</sup> Department of Built Environment Studies and Technology, Universiti Teknologi MARA, Perak Branch, Seri Iskandar, Perak, Malaysia

Email: fatihamohdyusof@uitm.edu.my

## Article history

**Received date** : 1-3-2022

**Revised date** : 2-3-2022

**Accepted date** : 25-6-2022

**Published date** : 1-8-2022

## To cite this document:

Mohd Noor, S. N., Saharuddin, S., Shamsudin, N. S., Abdullah, N. A., Ramly, M. K., & Mohamed Yusof, N. F. (2022). Industrialised Building System (IBS) In Public Building Construction: Profitability on The Implementation In School Building. *Journal of Islamic, Social, Economics and Development (JISED)*, 7(46), 115 - 126.

---

**Abstract:** *Industrialized Building System (IBS) was introduced and developed in Malaysia to be part of the solution to address the increasing demand for affordable housing, providing answer on foreign labour problems, improving cost effectiveness, and ultimately refining the quality, efficiency, and productivity of the construction industry. This paper intended to identify and discover the profitability factors from IBS application among contractors. Quantitative method of questionnaires survey was distributed to various contractors in Selangor which have experienced IBS construction mainly on public building projects. Ideally, the researcher found that by reducing number of labour, enhancing the knowledge of IBS player, reducing construction period and reducing waste material on site area are among the factors that bring profitability upon using IBS method.*

**Keywords:** *Industrialised Building System, Profitability Implementation, Public Building.*

## Introduction

The adoption of IBS is not a new topic in Malaysian construction industry. IBS is a construction technique in which materials are produced (on or off site) in a controlled setting, shipped, mounted, and assembled into a structure with limited additional site work. Even though many scholars emphasizing the advantages of using IBS method for construction, the adoption is still low due to various hurdles faced by stakeholders in applying the technology. According to (Construction Industry Development Board, n.d), in 2017 the government sector seeing higher adoption of IBS at 70% while private sector still experiencing relatively low adoption at only 15%. Meanwhile, in 2020, IBS project for government increased to 86.7% with 17.3% compared to 69.4% in 2016 (Muzamir, 2020.). Reference (Abedi, 2014) state that IBS focuses on improving the expertise and value of human resources, developing stronger collaboration and teamwork, and finally improving trust between parties in the construction industry. In addition, IBS usage also helps in promoting intelligibility, creativity, openness, and most importantly high integrity which ultimately improve productivity and efficiency in the construction industry. Besides that, in terms of quality, cost effectiveness, safety and health, waste reduction, efficiency and productivity, IBS has been described as a potential method to boost overall construction performance in Malaysia. In 2007, CIDB released a statistic report that highest adoption of IBS involving public building projects. The public building projects are constructions that will serve the purpose in providing services to the public such as public schools, court buildings, libraries, and religion buildings. Accordingly, a statement by former IBS Chairman, (Hussein, 2018) recommends all parties in local construction industries to use IBS as the system have the capability to save nearly 35-50% of construction costs. In 2020, Ministry of Works, Malaysia also released a statement confirming that 62 schools were successfully constructed using IBS where the time requires to complete the projects were 4-6 months lesser compared to conventional method. Besides that, utilization of IBS has proven to reduce construction cost through the lessening of labour cost (Z Ramli, 2016). Hence, this research focused its study on public school building as its case study.

## Literature Review

### Definition of Industrialised Building System (IBS)

IBS is known as construction system that is designed using prefabricated parts (Adnan, 2019), a production of building components either on or off-site in large-scale production (Jabar, 2018) represent the pre-fabrication concept (Hung, 2013) and construction technique that manufactures components in a controlled environment (Hamid, 2011). Ideally, IBS also being referred as off-site industrialized where building elements were assembled out from the site and can be assembled at factory or any other manufacture warehouse off sites. On top of that, this has brought various benefits such as decrease in trades and interfaces to handle and organize on site, better working conditions, better control and consistency, a fall in waste on and off site (Tg, Kingdom,2010), (Abedi, 2014), (Azman, 2011) and (Halil, 2016). (Azman, 2011) adds in that IBS is a way of speeding the construction process with a prefabricated concept in which each part is first installed in the component manufacturing plant. In order to improve the efficiency of construction projects, it is necessary to use modern technology such as the IBS.

### Situation of IBS in Malaysia

The construction industry is rising rapidly day by day and making major contribution for national growth rate. The industry has started to embrace IBS as a method of realizing better construction quality and productivity, reducing risks related to occupational safety and health, alleviating issues for skilled workers and dependency on manual foreign labour. At the end of

the goal was to reduce the overall construction cost (Khalil, 2016). In Construction Industry Transformation Program 2016-2020 - CITP, 2016; it emphasized that public project with value RM 10 million must adopt IBS at least 80% into its project and it was recorded that approximately 80% of public projects with value of RM10million and above have adopted IBS into their project deliverables. Meanwhile, 31.7% of private projects with value above RM 50 million have adopted IBS into their deliverables. In short, Malaysian construction industry is following the footsteps of the construction industry in developing country where adoption of IBS is growing as a method of attaining better construction quality and productivity as stated by (Construction Industry Development Board, 2017) and achieving the ultimate goals of reducing the overall cost of construction.

### **Classification of IBS in Malaysia**

There are six categories of IBS under the Malaysia Construction Development Board (CIDB) namely as Pre-cast Concrete Frame, Steel Formwork System, Steel Framing System, Prefabricated Timber Framing System, Block-work System, and Innovative On-Site System (Construction Industry Development Board, 2017).

#### **Precast Concrete Framing System**

Precast concrete framing system provides similar standardization, fast in construction, cost saving and high-end quality design. Reference (Hamid, 2011) in his study revealed that precast system known as economical system for high rise project due to the repetitive arrangement of construction. Precast components exist in various design and different purpose of usage. Most common group in precast concrete system are precast column, beams, walls, slabs, permanent concrete formworks, and '3D' components (Topic 4- Frame, n.d).

#### **Steel Formwork System**

Steel formwork system are suited for low- and high-rise building construction. This system offer speed in erection, cost saving and clearness equipment. Besides, it also offers strong cast precision and smooth inner finish that removes the need for plastering. Formwork steel system create safer environment on site and requires less labour than conventional method and can be re-used in many projects. (Hamid, 2011) mentioned that the initial cost of investment for steel formworks and moulds are lower than precast method, considering aspects needed to complete the buildings' shell structure. Hence this proved that the system is efficient and economical for high rise building construction. In addition, steel formwork system can be reused around 500-1000 times depends on way of use and it is an effective method to construct buildings that have similar layout.

#### **Steel Framing System**

The application of steel framing system only applicable for industrial and commercial building. In recent days, the application of steel roof trusses become competitive in comparison of timber roof trusses in construction industry. Hence, this showed that the system provide flexibility in design and fast return in investment for owners. This type of IBS system is commonly used with pre-cast concrete slabs, steel columns and beams. Steel framing systems have always been the popular choice, used extensively in the fast-track construction of skyscrapers. Recent development includes the increased usage if light steel trusses consisting of cost-effective profiled cold-formed channels and steel portal frame systems as alternatives to the heavier traditional hot-rolled sections.

### **Pre-Fab Timber System**

Before the invention of IBS, the local Malay and orang Asli ethnic group in Malaysia already using traditional houses with timber structure. The design and construction of buildings and structures using prefabricated wood and wood products included timber framework method especially structural or load bearing elements, (Hamid, 2011). Reference (Ariff, 2019) state that timber framing system show high aesthetic value and appearance with its own market demand. Commonly, this type of prefabricated timber frame was used specifically for places which requires high aesthetic values such as resort. However, recently the cost of timber production is higher compared to another types of IBS such as interlocking block system and maintenance requirement for timber have also becomes increasingly complicated.

### **Blockwork System**

The simplest and flexible system compared to other type of IBS that can be used in various project in industry. IBS blockwork can easily penetrate into market but need skilled designers to design the blockwork comparable to LEGO system. The block framework is easy for manufacture and easy for the adopters to assemble. According to (Hamid, 2011), the low-cost factor of this IBS with low capital investments have increased the interest among contractors.

### **IBS offer Profitability Through**

#### **Reduce Number of Labour and Expenses on Machineries**

IBS offer less reliable for foreign labour where Malaysian construction industry rely heavily on foreign labour resulting to increase in demand. The contractors are reluctant to switch into other construction method solutions that require higher capital with low labour rates as such IBS (Jabar, 2018). The adoption of IBS enables the market to reduce its reliance on foreign workers in which have brought benefits to the local economy. The reliance on foreign workers will decreased through the implementation of IBS and indirectly, the social problem among foreign workers will be reduce too (Maryam, 2009). Accordingly, productivity comparison between conventional and IBS method shown significant differences in numbers as such that 52 number of workers needed for conventional project while 25 number of workers for IBS project on the case study of Akademi Binaan Malaysia which were using both method (Construction Industry Development Board, n.d).

#### **Knowledge of the IBS Player**

Ideally, IBS knowledges among parties involves in the construction project also plays an important aspect. Research by (Construction Industry Development Board, n.d) compared cost between IBS and conventional construction on selected condominium through the case study made in Shah Alam. The study revealed that application using conventional method during initial tendered cost was quite high, convincing the client to used IBS formwork system in the project which eventually helps to reduce the actual price with around 7.69% cost saving. Therefore, knowledge among contractors and clients provides the opportunities to achieve cost saving by understand the alternatives available in the construction projects.

#### **Reduction Time of Construction**

Time is very essential to construction projects and always relates to cost. The shorten the time consuming for a project to be done, the lesser cost required for the project. The construction times for IBS projects can be shortened and this can save precious time and help to minimize monetary losses. Reference (Adnan, 2019) mentioned IBS also known as construction system that designed using prefabricated parts. Hence, component was made earlier prior to

construction begin. Research by (Faghirinejadfard et al., 2016), compared time differences between two projects of IBS project and conventional project. The findings show that, project with IBS components were completed sooner with rate of time differences of 45.8% and completed within 200 days, while conventional method takes around extra 35days from the IBS methods. Hence, IBS application helps to achieve construction projects to be completed on time and avoid any delay. Time reduction is one of the aspects that bring profitable on usage of IBS.

### **Reducing Waste Material on Site**

IBS was found to be the instrument method for reducing waste on site. Research by (Muhaidin, 2018) were comparing waste material between IBS projects and conventional project show that the breakdown waste production from conventional projects were steel bar (50.25%), miscellaneous (47.34%) and timber (2.21%). On the other hands, IBS projects produces waste around 0.77% for timber, 13.01% for steel bar and 19.98% for miscellaneous waste. Accordingly, the waste per gross floor area for conventional method is higher compared to IBS. This is due to the IBS projects using prefabricated materials compared to in-situ materials. Reference (Ahmad Bari, 2018) highlighted that on-site waste generation mainly linked to the method of construction, the availability of on-site sorting, recycling facilities for construction waste, level of education and training of staff. Therefore, waste management is a key element as part of the cost breakdown of construction projects.

### **Methodology**

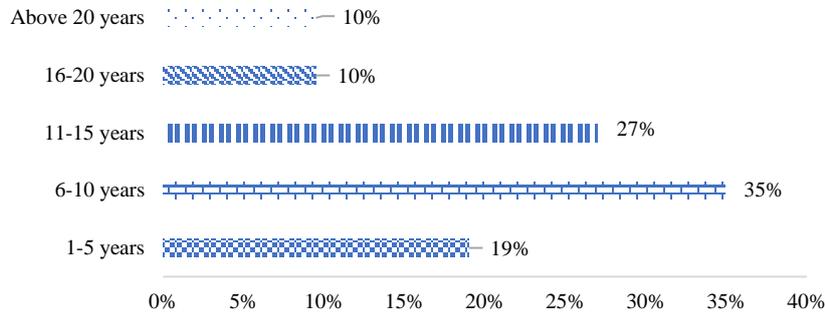
This research conducted using a quantitative method where questionnaires were distributed in form of online survey and postal survey. The questionnaires were divided into 4 sections: Section A insisted of demographic profiles, while in Section B, C and D consist of questions regarding profitability of IBS, factor adoption on using IBS and perception from respondents in regard to IBS. Data were collected based on stratified random sampling on the population of 1407 IBS contractors in Selangor. Then the population were stratified into district in Selangor and Petaling Jaya area was chosen with 698 IBS contractors in that area. According to (Krejcie, 1970) sampling table, 70 sample of IBS contractor were adequate for this research. The content of questionnaires was validated by expert panels of academics and industry professional before distributed. This research focused only for public building of school project in Selangor. Then data gathered from the questionnaires were analysed using SPSS then data were tabulated and discussed in the next section.

### **Result & Discussion**

#### **Demographic Profiles**

This section elaborates about years of experience and grade of contractors involves in this research.

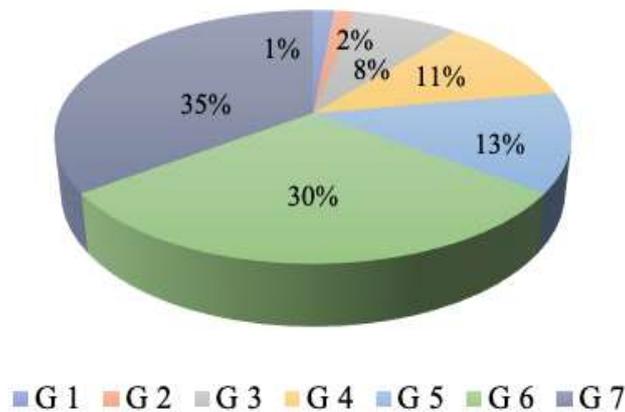
### Years of Experience



**Figure 1: Respondents' Years of Experience.**

Based on Figure 1. The largest percentage of contractors have years of experience between 6 to 10 years with 35% and followed by 11 to 15 years with 27%. Responses from contractors with 16-20 years and above 20 years experience are the least in percentage with 10% respectively and respondents from this category hard to be reached. In conclusion, the majority of contractors in Petaling Jaya with moderate experience (6 - 10 years) are progressively growing their experience to become expert as contactors. Meanwhile, experience contractors with more than 15 years might not majority origin from Petaling Jaya in Selangor.

### Grade of Contractor



**Figure 2: Contractor's Grade.**

Figure 2 illustrates the percentage of contractor according to Contractor class grade. Majority of the respondents in Petaling Jaya is Grade 7 contractors with 35% following with Grade 6 with 30%. The least contractors were coming from Grade 1 and Grade 2 contractors where concludes that Petaling Jaya region in Selangor majorly consists of well-established contractors with Grade 4 and above.

### IBS Project Experience Analysis

This section elaborates about number of projects involve and categories of IBS components involves in this research.

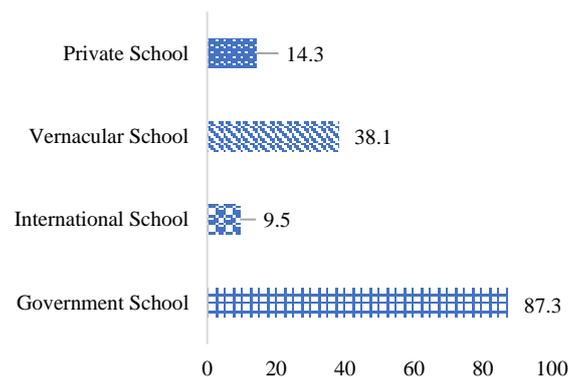
## Number of Project Involve

**Table 1: Number of projects involve**

Number of Project	Frequency	Percentage
1-10	26	41.30 %
10-20	24	38.10 %
21 and above	13	20.60 %
Total	63	100 %

Table 1 above illustrates number of project involves by the respondents as their contractors. Most of the respondents have the experience of handling project between 1 - 10 number of projects (41.30%), following with 10-20 number of projects (38.10%) and the least with 21 and above (20.60%).

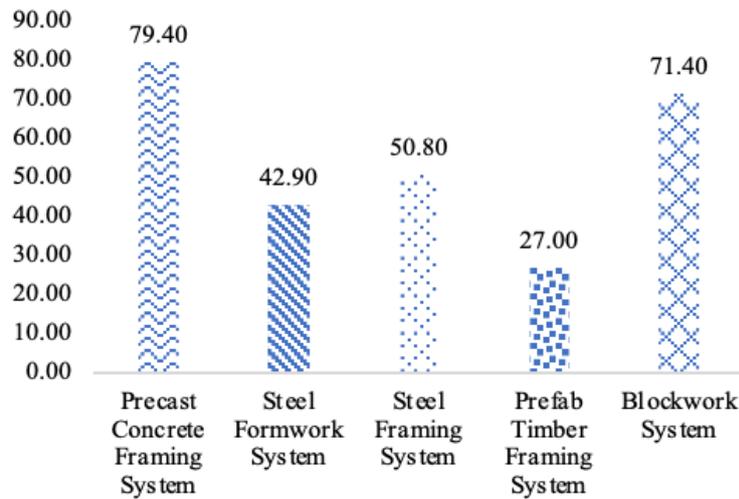
## Type of School Project



**Figure 3: Type of School Project.**

Figure 3 above show that the highest school projects was government school with 87.3% following with vernacular school of 38.1%. Meanwhile, 9 respondents experiencing in handling private school projects and only 6 number involve in international schools construction. Hence, this indicate that majority of the publing of building is governement school. This data are inlined with the government promotion under Construction Industry Transformation Programme, CITP 2016-2020 (CIDB, 2016) where public project should at least adopt IBS at the rate of 80%.

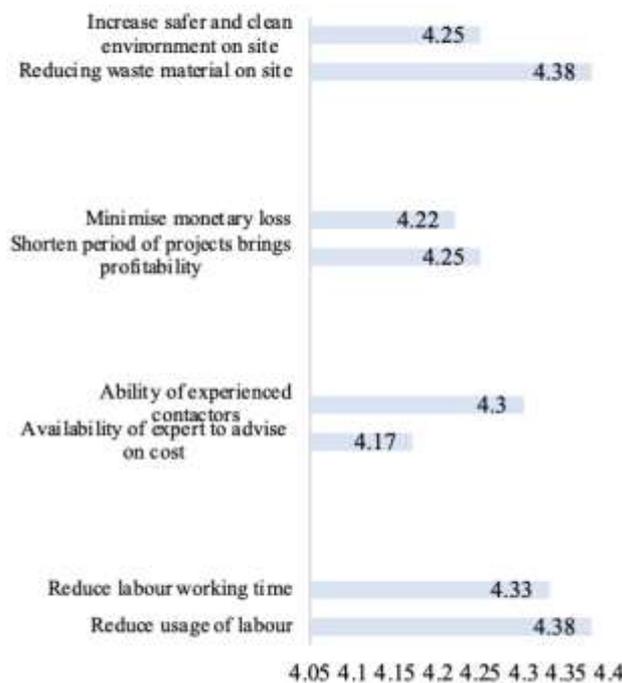
### Categories of IBS Involved



**Figure 4: Classification of IBS system.**

Figure 4 illustrates the IBS system widely used in construction of school buildings. 79.40% (50) of the respondents are using precast concrete framing system followed by 71.40 (45) respondents familiar with blockwork system and continue with 50.80% (32) have experience using steel framing system in the school building projects. The least system used was prefab timber framing system where this system were found less convenience in the current school building environment (Ariff, 2019).

### Identification of Profitability on IBS Application



**Figure 5: Summary of profitability from IBS application.**

Figure 5. above summaries the profitability of IBS which being discussed individually in the section below. Ideally, it can be summaries that, reducing the number of labour and reducing waste material on-site are among the most profitable element gained from IBS application in the school building projects.

### 1. Reducing Number of Labour

**Table 2: Reduce Number of Labour**

Items	Mean	Agreement Level
IBS offering profit by reducing number usage of labour	4.38	Strongly Agree
IBS offering profit by reducing labour working time	4.33	Strongly Agree

In this element of profitability, both items indicated strongly agree of agreement level with mean of 4.38 and 4.33. Hence this show that, these elements are strongly agreed by the contractors when they are using IBS in the school building projects. This data relates with research by (Maryam, 2009) where it states that the adoption of IBS is able to reduce the rely on foreign workers and can brought in benefits to the local economy. Eventually, this element brings profit by reducing the usage of labour.

### 2. Knowledge of IBS Player

**Table 3: Knowledge of IBS Player**

Items	Mean	Agreement Level
Availability of professional parties to revise the costing	4.17	Agree
Ability of experiented contractor for reduce wastage	4.30	Strongly Agree

Knowledge of IBS contactors play an important element where this expertise helps to provide advice and suggestions that relates to construction method, costing and any available alternatives needed in the case of issues arise on site. Both items were indicated with mean of 4.17 -agree agreement level and 4.30 – strongly agree agreement level. Based on these findings, most of the respondents agree that the contractors should be familiar with the construction methods, equipped with proper knowledge and technology applied on site. Data from the findings also supported with research (Tamrin, 2016) where the research emphasize on the knowledge of IBS and expertise for IBS is needed to ensure the IBS project are well-delivered. Consequently, this element will help to speed up and bring profitability to the projects.

### 3. Reducing Construction Period

**Table 4: Reduce Construction Period**

Items	Mean	Agreement Level
Offering profit by shorten period in construction project	4.25	Strongly Agree
IBS save precious time and minimise monetary losses	4.22	Strongly Agree

Based on Table IV, both items scored mean of 4.25 and 4.22 where it indicates that most of the respondents agree that IBS application reduces construction period. Reference (Wisam Mohamed, 2007) mentioned that faster completion of projects due to advance-off-site preparations and simplified version of installation process. Meanwhile, (Pheng, 1986.) highlighted about minimizing interest payment due to earlier occupation of building. On top of that, construction period can be shortened by managing construction schedule using planning control, estimated lead time and forecasted down time (Noorain, 2009). Therefore, the findings show agreement level of strongly agree for profitability in time for IBS application are in line with previous research study.

#### 4. Reducing Waste Material On-Site

**Table 5: Reduce Waste Material**

Items	Mean	Agreement Level
IBS offering profit by reducing waste material on site	4.38	Strongly Agree
Increase safer and clean environment on site	4.22	Strongly Agree

In this element of reducing waste material on site, both items scored strongly agree by respondents with 4.38 and 4.22 means respectively. The findings are supported by (Wisam Mohamed, 2007) where the research state that reduction of waste materials at site due to materials are casting in the factory. Reference (Construction Industry Development (CIDB) Malaysia, 2005) also emphasized the usage of IBS will helps to minimizing the use of formworks and props on site as all components are cast off-site. Hence, profitability is gained majorly in cost where minimization accrued from cost saving in transportation of materials and repetitive usage of mould from IBS components. Eventually, the reduction of waste helps to promotes cleanliness and neatness on site.

#### Conclusion

Based on the research conducted, it can be concluded that application of IBS in construction projects for public building gained profitability through reduction of labour on site, shorten the construction period, knowledgeable IBS player and reduction waste on site. On top of that, application of IBS inspires the usage of automation, mechanisation and prefabrication of components in boosting the productivity (Economic Outlook, 2022). The profitability gained are very distinct between IBS application method and conventional method. However, the limitation of this research only focusses on small population of contractors in Selangor. Researcher believed that future research should expand the research on IBS profitability to the whole contractor companies in Malaysia.

#### Acknowledgment

The authors are thankful to all respondents and expert panels involves in this research particularly for contractors in Selangor.

## References

- A. Faghirinejadfard, A.Mahdiyar, A.K. Marsono, S.R. Mohandes, H. Omrany, S.Tabatbaee, M.M Tap “ Economic comparison of Industrialised Building System and conventional construction system using building information modelling. *Jurnal Teknologi*, 78(1), 195-207, 2016
- B. Noorain, *Construction Technology and Innovation Development Sector*, CIDB Malaysia, January 2009
- C.I.B. Tg, TG57- Special Track 18TH CIB World Building Congress May, Salford, United Kingdom, 2010
- C.S. Pheng, “The scenario of Industrilised Building Systems in Malaysia” *Proceedings of UNESCO Regional Workshop, UPM Serdang*, 1986.
- CIDB, “ Construction Industry Transformation Programme, 2016-2020, 2016
- Construction Industry Development (CIDB) Malaysia, “IBS Digest January, January-March, 2005
- Construction Industry Development Board, “IBS Catalogue for Precast Concrete Building System, 2017
- Construction Industry Development Board, CIDB. “Study on Cost Comparison Between IBS and Conventional”. n.d
- Economic Outlook 2022, Ministry of Finance Malaysia, 2022.
- F.C. Hung, Z.A. Hamid, M.I.Din, R.M. Morman, “Study on industrilised building system (IBS) adoption level and contrecators readiness in Malaysia”, *Malaysia Construction Research Journal*, 17(1), 1-19, 2013
- F.D.A.A. Khalil, F.N.A Hassim, M.S Jaafar, “A review on Industrialised Building System issues in Malaysia” *MATEC Web of Conferences*, 47,0-3, 2016
- F.M. Halil, M.F. Mohammed, R. Mahbub, A.S. Shukur, “Trust attributes to supply chain partnering in Industrialised Building System”. *Procedia-Social and Behavioral Sciences*, 222, 46-55, 2016
- H. Adnan, A.B. Einur, A. Arzlee Hassan, M. Aisyah Asyikin & S. Khalidah Kaharuddin. “Success factors among Industrilised Building System (IBS) Contractors in Malaysia. *IOP Conference Series: Earth and Environmental Science*, 233(2), 2019
- I.L. Jabar, F. Ismail, “Challenges in the management of IBS construction projects” *Asian Journal of Quality of Life*, 3(9),37, 2018
- M. Abedi, M.S. Fathi, A. Mirasa, “ Establishment and development of IBS in Malaysia”. May, 2014
- M.A. Ariff, N. Haslinda Abas, A. Harina Azman, S. Khatijah Mohamad. “Identification of the Activity-based Hazard/risks involved in the IBS construction process: Case study of project that uses Prefabricated Steel Framing System and Prefabricated Timber Framing System. *IOP Conference Series: Materials Science and Engineering*, 601(1), 2019
- M.N.A. Azman, T.A. Majid, M.S.S. Ahamad, M.H. Hanafi, “A study on the trend of the use of IBS components and the setting up of IBS manufacturing factories in the Malaysia construction industry”. *Malaysia Construction Research Journal*, 9(2), 18-30, 2011
- M.Z Ramli, M. H. Hanipah, M. Hafiz Zawawi, M. Zaihafiz, N.A. Zainal & N.Syahiera. “Cost comparison on Industrialized Building System (IBS) and conventional method for school construction project. *Journal of Scientific Research and Development*. 3(4), 95-101, 2016
- Muzamir, M.Y, “Penggunaan IBS Meningkatkan”, *Berita Harian*, 2020.
- N. Tamrin, M.N. Mohd Nasrun, A.N. Faizatul Akmar,”Readiness in Knowledge and Ability for Implementation of Industrialised Building System (IBS) in Malaysia Construction Industry.2016
- N.A. Ahmad Bari, R. Mohd Yusuff, N. Ismail, A. Jaapar “Industrilaised Building System (IBS):

- It's attribute towards enhancing sustainability in construction. Asian Journal of Environment -Bahviour Studies, 3(8), 109-119, 2018
- N.H.M. Muhaidin, H.B Chan "The comparison of construction waste produced by conventional method against IBS: A case study in Pulau Pinang, AIP Conference Proceedings, 2018
- Q.O.Maryam, M.N.Kamal, S.M Bashar, " Advantages of Industrialized Building System in Malaysia", Student Conference on Research and Development (SCORED)m, Malaysia, 1-12, 2009
- R.V. Krejcie, D.W. Morgan "Determining Sample Size for Research Activities. Educational and Psychological Measurment.1970
- S.M.Wisam Mohamed "Simulation of allocation activities of logistic for semi precast concrete construction:case study", UTM, Johor, 2007
- Tan Sri Ir Jamilus Hussein, 2018
- Topic 4- Frame, "Construction Technology", RISM QS Education Subcommittee, Royal Institute of Surveyor Malaysia.
- Z.A.Hamid, K.A.M Kamar, M. Alshawi, "Industrilised Building System (IBS): Strategy, People and Process", 2011