Improvement of IBS Score Content in Construction Industry Standard (CIS) 18:2018

Mohamad Razi Ahmad Suhaimi
Faculty of Technical and Vocational, Sultan Idris Education University, 35900 Tanjong Malim, Perak, Malaysia

Mohamed Nor Azhari Azman
Faculty of Technical and Vocational, Sultan Idris Education University, 35900 Tanjong Malim, Perak, Malaysia

Mohd Firdaus Mustaffa Kamal
Faculty of Technical and Vocational, Sultan Idris Education University, 35900 Tanjong Malim, Perak, Malaysia

Natasha Dzulkalnine
Construction Research Institute of Malaysia (CREAM), Level 29, Sunway Putra Tower, No. 100, Jalan Putra, 50350, Kuala Lumpur

Jumintono
Magister of Management of Education, Universitas Sarjana Wiyata Tamaniswati Yogyakarta Indonesia, Jl. Kasumanegara 157 Yogyakarta 55165

Karnowo
Universitas Negeri Semarang, 50229 Semarang, Central Java, Indonesia

Abstract
The Industrialised Building System (IBS) has been implemented by the government as an alternative effort in reducing foreign workers in Malaysia. IBS advantages can be seen in its higher product quality, reduced waste of building materials, cost-effective, and faster construction times than conventional construction methods. The Construction Industry Standard (CIS 18:2010) has been introduced as a guideline manual to assist the industry on calculating the IBS score. The aims of this study is to identify the relevancy of the content used in the manual computation of existing IBS system in CIS 18:2010. Focus groups and interview sessions has been carried out for data collection. As a result from the industry feedback, there are several weightage changes in the usage of IBS components and the improvement of utilisation of standardized components based on MS 1064 for the IBS systems and also it has been suggested that these manuals need to be reviewed since it has been last updated in 2013. Overall, the finding from this study suggest that further improvement of the manual calculation in the existing IBS system content need to carry out to meet the needs of the construction industry in this country.

Keywords: Industrialized building system (IBS); Construction industry standard (CIS); IBS score.

1. Introduction
In line with the current housing demands in the global market, the construction industry has shifted its focus to mass production assembly in standardizing product development. This strategy has prompted the Malaysian construction industry to study the value added of construction industry from various countries that have achieved the implementation of prefabricated technology such as the United Kingdom (UK), United States (US), Australia, Singapore and Hong Kong (Azman et al., 2013; Blismas et al., 2010; Lovell and Smith, 2010; Omar et al., 2014; Majid et al., 2010).

In Malaysia, the prefabrication technology is known as Industrialised Building System (IBS) which is defined as a complete process system of construction works where almost all the component structures is manufactured onsite or offsite, the product is transported to the site and to be installed in the high precision coordinate joint as well as achieve high quality works, and accelerate the time of completion of the projects (Anuar et al., 2011; CIDB, 2010; Majid et al., 2010; Majid et al., 2011; Nawi et al., 2015). There are variety of terms used to describe the Industrialised Building System such as prefabrication, Modern Method of Construction (MMC), Offsite Manufacturing (OSM), Offsite Production (OSP) and OffsiteConstruction (OSC) are terms in common use at various times in the literatures. Those concepts are often use interchangeably when describing the characteristics of industrialized construction. Modern Method of Construction (MMC) is a term adopted in the United Kingdom as a collective description for both offsite based construction technologies and innovative onsite technologies (Goulding et al., 2012).

Thus, appropriate technology is required and global standardization has changed the past practices of the construction industry. Sometimes the advanced technology do not suit with the local condition on factors pertaining to the environment; level of workers’ skills, knowledge and competence; venerable resources and competent manufacturer to fabricate the mass production as well as high-quality products. Therefore, the construction industry
have adapt the technology to suit to the local condition, as very simple example on the advantages of Malaysia tropical weather, the manufacturer are able to cure the concrete by natural curing instead of using the oven with high investment and high maintenance. On the other hand, the same action was also taken by the government of Singapore and Hong Kong to spread the use of prefabrication system widely in public housing (Dulaimi et al., 2004; Tam et al., 2007). Prefabrication enable to build up high rise building and able to send the prefabrication components to the limited access area and the component is directly erected from the crane. Therefore, IBS is suitable for cities and regions with the problems of dense population and with insufficient land for housing development.

The government has encouraged the construction industry to move towards IBS which can produce high volume of houses at affordable cost especially low-cost houses. Government agencies such as Jabatan Kerja Raya (JKR) and Construction Industry Development Board (CIDB); and researchers have played vital roles to educate the main players of the construction industry in the form of policies, financial incentives, strategy guidelines, workshops and seminars to increase the awareness among the end users and clients.

To further strengthen the use of IBS in the country, the IBS policy was issued in 2008 where the rules on the use of IBS in the construction of public buildings must be not less than 70 scores from IBS scores and in the sense that IBS should also be included as part of the document contract for tender (Hamid et al., 2008).

Construction Industry Standard (CIS) is a reference and guide to construction industry players. Apart from that, the CIS has also become a reference source and the scientific materials used in the syllabus at universities involving the subject of construction. To ensure that the CIS has a positive impact on the industry, reviews and improvements are needed. According to the Stage Effectiveness Study Program Standards to Stakeholders that were conducted on 1 to 20 September 2013 by the Malaysian Qualifications Agency's Standard Division found that the duration and requirements of the program standard review were for five (5) years.

The Construction Industry Standard (CIS 18: 2010) was published in 2010 and has now reached its seven-year use. It is therefore necessary to make improvements and revisions of the standards to meet current industry requirements. A series of workshop has been done to suggest a recommendation towards the previous CIS. New elements have been added such as Building Information Modelling (BIM) and Prefinished Prefabrication Volumetric Construction (PPVC) while some scoring content has been changed to suit the productivity and number of workers usage.

Construction Industry Standard (CIS) is the standard used in the construction industry issued by CIDB. To issue a standard, the CIDB will act as a moderator and facilitator for the working group throughout the development process of this standard. The CIDB is also responsible for providing a platform for private sector-wide discussions and the government including organising the workshops for the development and improvement of the standards (CIDB, 2015).

This study was conducted in order to assist and benefit the stakeholders such as CIDB Malaysia and construction industry players in general. Construction industry players, especially those directly involved in the IBS construction project, require the latest construction standards to assist them in full engagement. The results of this study will give input and further knowledge to be standardised in CIS 18 which will be used by CIDB Malaysia. The CIS 18 will be the official document and will be used by the construction industry as a reference document in the calculation of IBS content in a building.

2. Formula of IBS Scoring System

The formula of IBS score system involving structural system, wall system and other simplified construction solutions which are the weightage for structural system is 50, wall system is 20 and other simplified construction solutions is 30.

\[
50\sum \left[\frac{Q_S}{Q_{ST}} F_S\right] + 20\sum \left[\frac{Q_w}{Q_{WT}} F_W\right] + S
\]

Where:
- \(\Sigma\) - Sum of
- \(Q_S\) - Construction area of a structural system
- \(Q_{ST}\) - Total construction area of building
- \(F_S\) - IBS Factor for structural system (refer Table 1)
- \(Q_w\) - Length of a wall system (external or internal wall)
- \(Q_{WT}\) - Total wall length (external or internal wall)
- \(F_W\) - IBS Factor for wall system (refer Table 3)
- \(S\) - IBS Score for other simplified construction solutions (refer Table 4)

2.1. Structural System

The full points given under structural system are 50 points. Points are awarded based on the structural system used. Calculation is based on the floor area that utilises the structural system. Sub-structure works (elements) are not considered in the calculation. Example of sub-structure works are such as piling, ground beam, ground slab,
underground car park etc. The construction area includes car porch but excluding driveway, apron and landscaped areas.

\[ 50 \sum \left[ \frac{Q_s}{Q_{ST}} F_s \right] \]

Where:

- \(Q_s\) - Area of construction system is used
- \(Q_{ST}\) - Total construction area of the building
- \(F_s\) - IBS Factor for structural system (refer Table 1)

| SYSTEM | COLUMN / BEAM | FLOOR | Precast concrete slab\(^{(1)}\) | In-situ concrete on permanent metal formwork | In-situ concrete using reusable system formwork | In-situ concrete using timber\(^{(6)}\) formwork | Steel flooring system | Timber frame flooring system | No Floor\(^{(5)}\) |
|--------|---------------|-------|---------------------------------|---------------------------------------------|-----------------------------------------------|---------------------------------------------|---------------------|--------------------------|--------------------------|
| CONCRETE |               |       | 1.0                             | 0.9                                         | 0.7                                           | 0.6                                          | 1.0                 | 1.0                      | 1.0                      |
|        |               |       | 0.9                             | 0.8                                         | 0.8                                           | 0.5                                          | 0.9                 | 0.9                      | 0.8                      |
|        |               |       | 0.8                             | 0.7                                         | 0.5                                           | 0.4                                          | 0.8                 | 0.8                      | 0.7                      |
|        |               |       | 0.9                             | 0.8                                         | 0.6                                           | 0.5                                          | 0.9                 | 0.9                      | 0.8                      |
|        |               |       | 0.8                             | 0.7                                         | 0.5                                           | 0.4                                          | 0.8                 | 0.8                      | 0.7                      |
|        |               |       | 0.8                             | 0.7                                         | 0.5                                           | 0.3                                          | 0.7                 | 0.7                      | 0.6                      |
|        |               |       | 0.8                             | 0.7                                         | 0.6                                           | 0.5                                          | 0.8                 | 0.8                      | 0.7                      |
| STEEL | Vertical and horizontal member systems / structure | 0.8 | 0.7 | 0.5 | 0.3 | 0.0 | 0.6 | 0.8 | 0.7 |
|        | Steel columns and beams | 1.0 | 0.9 | 0.7 | 0.6 | 1.0 | 1.0 | 1.0 | 1.0 |

Source: Construction Industry Standard (CIS), 2010

Structural system also including the roof structural system which the IBS factor as explained in Table 2.

Table-2. IBS Factor for Roof Structural System

| No | Roof System            | IBS Factor |
|----|------------------------|------------|
| 1. | Prefab timber roof truss | 1.0        |
| 2. | Prefab metal roof truss | 1.0        |
| 3. | Precut metal roof truss | 0.5        |
| 4. | Timber roof trusses     | 0.0        |

Source: Construction Industry Standard (CIS), 2010

2.2. Wall System

The full points for wall system is 20 points. Points are awarded based wall system used. Allocation based on length of the wall system used.

\[ 20 \sum \left[ \frac{Q_w}{Q_{WT}} F_w \right] \]
Where:
Qw - Length of wall system is used
Qst - Total wall length of the building
Fw - Refer from Table 3

| No. | Wall System                                 | IBS Factor |
|-----|---------------------------------------------|------------|
| 1.  | Precast Concrete Panel                      | 1.0        |
| 2.  | Wall Cladding                               | 1.0        |
| 3.  | Prefabricated Timber Panel                  | 1.0        |
| 4.  | Full Height Glass Panel                     | 1.0        |
| 5.  | Dry Wall System                             | 1.0        |
| 6.  | In-situ Concrete with Reusable System Formwork | 0.5      |
| 7.  | In-situ Concrete with Timber Formwork       | 0.0        |
| 8.  | Precision Blockworks                        | 0.5        |
| 9.  | Pre-assemble Brickwall / Blockwall          | 1.0        |
| 10. | Common Brickwall                            | 0.0        |

Notes:
1) Precast concrete panels include sandwich panel, solid panel, hollow core panel and bay-window.
2) Wall cladding consists of panel acting as wall or façade and not as a skim to brickwall.
3) For full height windows, use the IBS factor for panel glass.
4) Precast dry wall includes cementitious panels and composite gypsum boards.
5) Reusable formworks include plastics, fiberglass, steel, aluminium and other metal formworks that can be used repeatedly.
6) Timber formwork (timber roof trusses) means the timber components are sized, cut and fabricated in-situ to form the formworks and the required temporary works. (stick built).
7) Blockwork system either (loadbearing or non-loadbearing) includes hollow block, interlocking block, lightweight concrete block that can be laid on adhesive mortar.
8) Pre-assemble brickwall/blockwall means brick that being laid in form of a panel and transported to site.
9) Wall constructed using tunnel formworks, use factor of 0.6.
10) For other structural systems not mentioned in the table please refer to CIDB for the IBS factor.

2.3. Other Simplified Solutions
The full points given under other simplified construction solutions is 30 points. Points are awarded based on utilisation of construction methods or solution that can contribute to the objectives of IBS as follows:
1. Use of standardised components.
2. Repeating features – grids, floor height
3. Vertical repetitions, horizontal repetition

| No. | Description                                      | Unit | IBS Score | Percentage of Usage |
|-----|--------------------------------------------------|------|-----------|---------------------|
|     | **UTILISATION OF STANDARDISED COMPONENT BASED ON MS 1064** |      |           |                     |
| 1   | Beams                                            | Nos  | 2         | 4                   |
|     | Columns                                          | Nos  | 2         | 4                   |
|     | Walls                                            | m²   | 2         | 4                   |
|     | Slabs                                            | m²   | 2         | 4                   |
|     | Doors                                            | Nos  | 2         | 4                   |
|     | Windows                                          | Nos  | 2         | 4                   |
| 2   | **REPETITION OF STRUCTURAL LAYOUT**              |      |           |                     |
|     | For building more than 2 storeys                 |      |           |                     |
|     | Repetition of floor to floor height              | Nos  | 1         | 2                   |
|     | Vertical repetition of structural floor layout   | Nos  | 1         | 2                   |
|     | Horizontal repetition of structural floor layout | Nos  | 1         | 2                   |
|     | For building 1 or 2 storeys                      |      |           |                     |
|     | Horizontal repetition of structural floor layout | m²   | 3         | 6                   |
3. Methodology

The research instrument involves interview and focus group. The interview questions used are semi-structured questions and conducted by face to face interview. Focus groups are group interviews that give the researcher the capability to capture deeper information more cautiously than individual interviews. Respondents for the focus group are the experts in the IBS construction industry. Respondents can be divided into two sectors, namely private and government including architects, consultant’s engineers, contractors, IBS component installers, IBS component suppliers, CIDB’s Technology & Innovation Division Officers and officers from Public Works Department Public Works Structure (JKR CKAS).

| No  | Position                        | Company                     | Experience (Year) |
|-----|---------------------------------|-----------------------------|-------------------|
| 1   | Senior General Manager          | CIDB                        | 32                |
| 2   | General Manager                 | CIDB                        | 35                |
| 3   | Executive Vice President        | Setia Precast SdnBhd        | 33                |
| 4   | Chief Executive Officer         | Teraju Precast Services SdnBhd | 27            |
| 5   | Chief Executive Officer         | Castwell Industries SdnBhd   | 33                |
| 6   | Chief Executive Officer         | Portland Arena SdnBhd       | 27                |
| 7   | Assistant Manager               | KumKang Industrial SdnBhd    | 27                |
| 8   | Assistant Manager               | Jet Formwork & Scaffold SdnBhd | 30            |
| 9   | Technical Manager               | Starken AAC SdnBhd          | 22                |
| 10  | Manager                         | MM2 Building Sys. SdnBhd    | 25                |
| 11  | Chief Executive Office          | Innovacia SdnBhd            | 25                |
| 12  | PAM Council Member              | PertubuhanArkitek Malaysia (PAM) | 32       |
| 13  | PengarahKhidmatPakar dan Pengurusan, | Public Works Department (PWD) | 35       |
| 14  | Executive Director              | Integrated Brickworks SdnBhd | 35                |
| 15  | Manager                         | Asia Roofing Industries SdnBhd | 25            |
| 16  | Deputy CEO                      | Kumpulan Sakata SdnBhd      | 30                |
| 17  | Manager                         | PU Profile SdnBhd           | 28                |
| 18  | Senior Manager                  | CIDB                        | 31                |
| 19  | Senior Manager                  | CIDB                        | 25                |
| 20  | Manager                         | CIDB                        | 10                |
| 21  | Manager                         | CIDB                        | 8                 |
| 22  | Assistant Manager               | CIDB                        | 25                |
| 23  | Assistant Manager               | CIDB                        | 25                |

4. Factors Influencing IBS Score Content

The factors influencing IBS content for three systems which are structural system, wall system and other simplified construction solutions are depending on the:

4.1. Usage of IBS Components

The usage of IBS components used in the projects will contribute to higher IBS score. Input from the focus group discussions; “IBS factors depend on the number of worker during the installation process.” & “Permanent formwork involves three (3) step/work methods ie; 1.installation, 2.steel installation, 3.concreting work”.

4.2. Utilisation of Standardized Components Based on MS 1064

This Malaysian Standard was developed by the Working Group on Preferred Sizes and Coordinating Sizes for Masonry Bricks and Blocks supervised by the Technical Committee on Modular Coordination under the authority of the Building and Civil Engineering Industry Standards Committee. The parties involved in the development of this standard are Construction Industry Development Board Malaysia (CIDB) which is the Standards-Writing Organisation (SWO) selected by SIRIM Berhad to develop standards for the construction industry.

The content of MS 1064 involved ten (10) parts. The parts that related to IBS is part 4, 5 and 10. Part 4 is Coordinating sizes and preferred sizes for doorsets, Part 5 is Coordinating sizes and preferred sizes for windowsets and Part 10 is Coordinating sizes and preferred sizes for Reinforced Concrete components.

- Repetition of structural layout
- Usage of other productivity enhancing solutions such as volumetric modular units, Building Information Modelling (BIM) and Modular gridlines.
5. IBS Score System Improvement

In 2010, the CIDB has made improvements from the first version of the IBS Score by changing the Part 2 Wall System from 30 scores to 20 scores and for Part 3 Other Buildings Methods from 20 scores to 30 scores. This change can help in encouraging the use of Modular Coordination (MC) in building construction. Table 5 shows the IBS score assessment with maximum IBS score for a building is 100%.

Table 5
| System                      | Elements                                                                 | Score |
|-----------------------------|--------------------------------------------------------------------------|-------|
| Structural System           | contributes most wet trade; 75% labour                                  | 50%   |
| Wall System                 | widely available in the market                                           | 20%   |
| Other Simplified Construction Solutions | standardized components MS1064; repetition; 3D components | 30%   |

5.1. Findings from the Focus Group Discussion

| System                          | Issue                                                                                      |
|---------------------------------|--------------------------------------------------------------------------------------------|
| Structural System               | The numbering for columns and beams and coding. IBS factors depend on the number of worker during the installation process. Any system using reusable formwork to be consider reduced by 0.1 (factor). Permanent formwork involves three (3) step/work methods ie; 1.installation, 2.steel installation, 3.concreting work. Precut metal roof trusses in the IBS factors for roof structural system must be removed because it is a conventional construction method. |
| Wall System                     | pre-assemble brick wall / blockwall need to be discarded because it is not practical and not used in this country. |
| Other Simplified Construction Solutions | To consider Building Information Modelling (BIM) and prefab bathroom units (PBU). BIM Level 1 and BIM Level 2 must be considered to added. To added in the other productivity enhancing solutions for Prefab bathroom units (PBU), prefab staircases include completed staircase units made of precast, steel, engineered timber, or any other prefab materials. |

6. Conclusion

Added new items which are Timber and Innovative because they are in six (6) types of IBS. BIM is included in the manual because of the implementation in the construction project in Malaysia. The significance of higher IBS score implementation shown the level of productivity, reduction of site labour, lower wastages, less site materials, cleaner environment, better quality, neater and safer construction sites, faster project completion as well as lower total construction cost in the Malaysian construction industry.

The purpose of the review IBS score is to update the document based on the current situation which involves the new technology in the construction sector such as Prefabricated Prefinished Volumetric Construction (PPVC) and Building Information Modelling (BIM). The comparison between the previous one and the suggested recommendation is to add the elements of Building Information Modelling (BIM) and Prefabricated Prefinished Volumetric Construction (PPVC) in the standard.

Besides that, in the structural system, a few items are added such as metal and blockwork. Most of the items in the structural system is reduced by 0.1 because taken into consideration that involved more process, longer installation period and more workers required, thus will lead to the less productivity in the construction project. However, two items were increases in the no slab description because it was considered as conventional way of construction.

In the wall system the pre-assemble brickwall / blockwall is removed because the system is not available in Malaysia. The new wall system added is In-situ concrete with permanent formwork because of the innovation in the IBS construction. The IBS factor of in-situ concrete with reusable system formwork is reduced by 0.1 because of the level of productivity in the construction process.

In other simplified solutions under Other Productivity Enhancing Solutions, the PPVC and BIM is suggested to be added in the standard. The definition of BIM Level 1 and BIM Level 2 is also explained in the standard. The
PPVC involves the development of the Prefab Bathroom Unit (PBU). These two elements are added because there is a shift in technology in the Malaysian construction industry.

References
Anuar, K., Kamar, M., Hamid, Z. A. and Nor, M. (2011). Industrialized building system (IBS): Revisiting issues of definition and classification. Int. J. Emerg. Sci., 1(6): 120-32.
Azman, M. N. A., Ahamad, M. S. S., Majid, T. A., Yahaya, A. S. and Hanafi, M. H. (2013). Statistical evaluation of pre-selection criteria for industrialized building system (IBS). Journal of Civil Engineering and Management, 19(9): S131-S40. Available: https://doi.org/10.3846/13923730.2013.801921
Blismas, N., Wakefield, R. and Hauser, B. (2010). Concrete prefabricated housing via advances in systems technologies-Development of a technology roadmap. Engineering, Construction and Architectural Management, 17(1): 99-110. Available: https://doi.org/10.1108/09699981011011357
CIDB (2010). IBS-roadmap 2011-2015. Construction Industry Development Board Malaysia.
CIDB (2015). Construction industry standard CTS 18:2010 Manual for its content scoring system (IBS score).
Dulaimi, M. F., Ling, F. Y. Y. and Ofori, G. (2004). Engines for change in Singapore’s construction industry: An industry view of Singapore’s Construction 21 report. Building and Environment, 39(6): 699-711. Available: https://doi.org/10.1016/j.buildenv.2004.01.011
Goulding, J., Nadim, W., Petridis, P. and Alshawi, M. (2012). Construction industry offsite production: A virtual reality interactive training environment prototype. Advanced Engineering Informatics, 26(1): 103-16. Available: https://doi.org/10.1016/j.aei.2011.09.004
Hamid, Z. A., Kamar, K. A. M., Zain, M. Z. M., Ghani, M. K. and Rahim, A. H. A. (2008). Industrialised building system (IBS) in Malaysia: The current state and R&D initiatives. Malaysian Construction Research Journal, 2(1): 1-13.
Lovell, H. and Smith, S. J. (2010). Agencement in housing markets: The case of the UK construction industry. Geoforum, 41(3): 457-68. Available: https://doi.org/10.1016/j.geoforum.2009.11.015
Majid, T. A., Azman, M. N. A., Zakaria, S. A. S., Zaini, S. S., Yahya, A. S., Ahamad, M. S. S. and Hanafi, M. H., 2010. "The industrialized building system (IBS) survey report 2008 - Educating the Malaysian construction industry." In In 2nd International Conference on Computer Research and Development, ICCRD 2010 pp. 615-19.
Majid, T. A., Nor, M., Azman, A., Akmam, S., Zakaria, S., Shukri Yahya, A. and Hanafi, H. (2011). Quantitative analysis on the level of its acceptance in the Malaysian construction industry. Journal of Engineering Science and Technology, 6(2): 179-90. Available: https://s3.amazonaws.com/academia.edu/documents/33202321/2011_JESTEC.pdf?AWSAccessKeyId=AKIAIWOWYGYZ2Y5UL3A&Expires=1538590999&Signature=ugY%2BUNg2WeNteSytwxXZuYD1oAc%3D&response-disposition=inline%3Bfilename%3DQUANTITATIVE_ANALYSIS_ON_THE_LEVEL
Nawi, M. N. M., Azman, M. N. A., Baluch, N., Kamar, K. A. M. and Hamid, Z. A. (2015). Study on the use of industrialised building system in Malaysian private construction projects. ARPN Journal of Engineering and Applied Sciences, 10(17): 7368-74.
Omar, M. F., Nursal, A. T., Nawi, M. N. M., Haron, A. T. and Goh, K. C. (2014). A preliminary requirement of decision support system for building information modelling software selection. Malaysia Construction Research Journal, 15(2): 11-28.
Tam, V. W. Y., Tam, C. M. and Ng, W. C. Y. (2007). On prefabrication implementation for different project types and procurement methods in Hong Kong. Journal of Engineering, Design and Technology, 5(1): 68-80. Available: https://doi.org/10.1108/17260530710746614