Compatibility Issues of Industrialized Building System (IBS) in Interior Construction: A Case Study in Kuala Lumpur

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Abstract. The Construction Industry Development Board Malaysia (CIDB) defines Industrialized Building System (IBS) as a construction technique in which components are manufactured in a controlled environment (on or off-site), positioned, transported and assembled into a structure with minimal additional site works. Such as, component that are being pre-fabricated in a controlled environment on-site are also considered as IBS. Main problem is when the contractors have bad workmanship while using pre-fabricated panels at site and IBS components are deliberated to be inflexible with respect to be changes or renovations. The aim of this research to identify the issues of compatibility of Interior construction in IBS components. This study will concentrate on interior construction works using of IBS components. The importance of this research is to establish design for solution the issues in using IBS components in interior constructions. This research also to develop design criteria of IBS components that have advantage and disadvantage in interior construction industry in Malaysia. According to this study, the availability of knowledge and information on IBS components for interior construction will be contribute to others. This research also develops new design criteria benefits to designer that using IBS components at site. In long term this research will implement as set of guidelines and additional knowledge that may encourage usage of user and CIDB.

1. Introduction
Construction Industry Development Board Malaysia (2001) imply IBS as a technique in building construction whereby the material components are pre-fabricated off-site or in a regulated setting, organized, transported and constructed into a completed construct with minimum fixing and installation work at the construction site [1]. CIDB further explained that component of building construction that being pre-fabricated in the working site under a controlled setting is also recognized as an IBS system. Eventhough there are various research being conducted in defining the Industrialized Building System (IBS) concept, the concluded findings suggested that IBS construction method concerned with prefabricated components or it being mass-produced off-site [1, 2].

The major problem with IBS system is that the contractors are poor in workmanship when installing pre-fabricated components at construction site. This can cause problems in the termination joints, hence resulted water leaks and eyesores. In the tropical country such as
Malaysia whereby precipitations virtually falls almost daily, the issues is very critical. To address all these problems, the designers need to diligently examine thoroughly the finished units upon handover in order to verify that the developer addressed all defect works. Another issue related with pre-fabricated components is that IBS system are considered as inflexible with respect to alterations or reconstructions. Most people likely want to make installation holes for wall fixtures or may add other feature on the wall. But certainly, in renovation works there might be hacking in order to provide additional conduits and electrical wirings that might be compromised the systems or components. Or it might arise a problems in trying to demolish down certain walls in order to combine two units to become larger one unit if units is contiguous to each other. The deficiency of methods and tools in the constructions defining a value. The main point is to develop a criteria or guidelines for designers decisions making when using the system. Each sustainable criteria performance must be address to solve the hidden prospects of implementing IBS construction system [2]. According to [3, 4] the limited knowledge about IBS construction system, plenty of cheap inexpirt labors and huge initial investment outlay some of the barriers in implementing IBS construction systems [3, 4]. These rendered causes and difficulties will affect designers and constructors to opt for conventional approach instead of implementing IBS construction systems. According to Hussein, 2009, he added that key stakeholders in construction industry have undesirable views towards implementing IBS construction systems [5]. To homogeneously and broadly define the sustainability concept and the vital aspects in built environment is to consider sustainability evaluation of the built facilities [6]. The research problem is lack of knowledge by the designers in implementing IBS construction system. This study findings will assist the designers in identifying and managing the economic, social and environmental risks in a holistic manners. The conclusions will validate the guidelines and help the designers in determining the advantages and limitations of utilizing IBS material components and maximized the use of the system.

2. Research Framework

The research type used in this study is explanatory method to determine the current situation, issues, and problems in IBS system components and obtained a new understanding from another perspectives. In this study, the correlated variables are recognized and hypothesizes in order to generate future study [7].

From the concept of this study, the conceptual framework was synthesized as shown in Figure 1.

![Figure 1. Framework of Study.](image)
2.1 Objectives
The objectives of this research are to distinguish the significant understanding of stakeholders in IBS system components throughout the period of construction. The information and application are expended to develop preliminary study framework. There are three key point questionnaires are being conducted:
1) **To identify** the problem statement concerning compatibility of interior construction in Industrialized Building System (IBS).
2) **To develop** design criteria in interior construction of using Industrialized Building System (IBS) material components.
3) **To establish** design for solution the issues of Industrialized Building System (IBS) in interior construction.

3. Methodology
The methodology chosen must matched the addressed research questions. In this study, a combined data will deliver the utmost comprehensive problem statement analysis. The main problem of this study will lead to answer the addressed study question. For appropriate and thorough analysis, this study will develop a decision making guideline for designer understanding in implementing IBS system components in building construction particularly in interior works. Figure 2 below indicated the study method framework.

![Figure 2. The Study Method Framework](image)

This research involves a number of sampling in answering the questionnaires. Besides the survey questionnaires, this study also used structured interview in order to obtain data and input from varies experienced and expert respondents in enhancing the comprehension towards solving the main study problems.
The sequential of research design, combined both quantitative and qualitative data [8]. The entire investigation is presented as a combination of both types of gathered data. The sequential strategies of the study is as indicated in the Figure 3.
In this study, the developed guidelines are based on every issue in-depth investigation via semi-structure study interviews. Thus, it will improvise understanding on the positive and negative aspect and contexts within proper investigation. Table 1 below indicated the summary of the selected method.

**Table 1. Summary of the Selected Method**

| Study Method               | Key Aspects                                                                 | Objectives                                                                 |
|----------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------|
| **Survey Questionnaires**  | • All targeted respondents                                                  | • Examine the probable IBS stakeholders                                   |
|                            | • A variables quantity to be quantified and analyzed                         | • obtaining consensus from various types of stakeholders                   |
|                            | • No physical context                                                       | • statistically analyzed the respondents feedback.                         |
| **Semi-Structured Interviews** | • investigate directly the recognized probable factors                     | • validating the study framework grounded based statistical examination   |
|                            | • provide discussion on devising the efficiency of IBS system components    | • develop the decision-making guidelines for improving the understanding of IBS components |
|                            | • allow researcher to pursue and ratify the addressed issues                | • obtain opinions by responding to every vital factors                    |
| **Case Studies**           | • allow researcher to investigate the comprehended framework and guidelines developed | • investigate on how the formulated guidelines were used in addressing problems of IBS system components |
|                            | • Indicates the procedures, needed actions and required activities concerning the issues in IBS system components in interior construction | • explore the procedures, process and activities affected the decisions-making |
|                            |                                                                            | • measure the effectiveness and practicality of the formulated guidelines  |

To improve the IBS system components understanding within IBS stakeholders, the decision-making guidelines are develop as the final findings of this study. This sections is to explain the study process implicated in developing the guidelines. The study process was based from the preceding study by Riduan Yunus (2012) [10], whereby the presented step is embraced in developing decision-making guidelines for IBS stakeholders. To further improve the understanding for best decision among IBS stakeholders, SWOT analysis method was adopted.
4. Result

Survey Questionnaires. The surveys are conducted to examine the stakeholders’ understanding on Industrialized Building System (IBS) in the field of interior construction. Founded on the survey conducted, the following findings can be concluded:

1. The stakeholders understood that IBS system components are not easily installed or use for interior construction.
2. The stakeholders understood that IBS systems are more advantageous in term of speed, quality and safety during the period of construction.
3. The stakeholders are still comparing the conventional system and IBS system based the problems that they encounter throughout the construction phase.
4. The IBS systems need to be more detail during the planning and design phases.
5. The stakeholders are still unwilling to recommend the IBS systems in their future coming projects due to higher cost during construction, knowledge lacking among the workers, failure design during the implementation and not clear guidelines in Malaysian construction industry.
6. The authority or government should reward more incentive via the related construction bodies.
7. The related construction bodies should come up with more campaign or conferences in encouraging the designers to specified design based on IBS systems.

Interview. This method present the analyze result based on semi-structured interviews. It provide in-depth understanding concerning IBS systems from respondents who answer the questions. The critical circumstances during phases of construction were deliberated and validated by the respondents. This method is important in order to ensure the vital factors and
problems in IBS systems during construction phases can be identified and improvised in the near future. Based on given view, the respondents provide the possibility to stakeholders in gaining more knowledge on IBS systems. The SWOT investigation and commendations is formulated based on the feedback response in order to develop criteria guidelines in assisting designers to appraise the issues and principles on IBS systems in design process.

**Case Studies.** The outcome from this method in this study is to develop an answer or guidelines to help designers improve their understanding on IBS systems during interior design and construction phases. The on-site observations of real projects is to help researcher in improvising the understanding on IBS systems. Thus, to ensure the results which translated as guidelines can be used as deciding tools for designer. The process involved when using guidelines can assist the designers in attaining the appropriate decision at the early planning and design phases. It will act as a reference guide for the designer to understand the systems before implementation or construction.

5. Conclusion

The support from the Construction Industry Development Board Malaysia really facilitate the researcher in identifying the stakeholders that implementing IBS systems in their projects [11]. The conceptual framework focused on vital issues which are highlighted from beginning of the research stage. The identified critical issues is to help elevating the awareness between industry key players, understanding the systems, the concern issues and how to manage it on-site. In this study, the SWOT analysis is to redefine the identified issues whether internal or external aspects concerning IBS systems. The SWOT analysis also will assist the designers or related users in making appropriate system components selection for interior construction phase. In this study, majority of respondents prefer to have a reference guide on IBS systems for interior construction. This study is also to provide a result and guides for space designers who are the decision maker during design phase.

The limitation of this study is that throughout the research, the focus is towards types of IBS systems and the demanding issues of current IBS implementation. From study planning and recommendation from chosen respondents, are based on their experience and knowledge in building industry. During construction phase of projects, many persons involved in decision making even though the same objectives is to complete the project. Every respondents need to call for a decision making which can be improvised and optimized. Hence, there might be non-uniformity on the feedback as the respondents in this study are varies in background and implementation process but yet to deliver decision making.

For future research, this study has embark in more opportunities to investigate on the development of IBS systems and for interior design construction. It’s recommended that the findings in this study can used to review and redefine the guidelines for IBS implementation. Focus should be emphasize on the materials, standardization of procedure and work skills. Consideration need to be given for refurbished spaces or buildings that implementing IBS systems. Future study should also investigate the way to minimize the problems pertaining IBS system during interior fit-out or refurbishment in building. Other aspects is to relate electronic tools for guideline information, so that it will be more systematic in analyzing and processing the IBS system input. The auto-generated report ease the procedure and process via the electronic guideline tool. Knowledge and data from the IBS stakeholders also can be easily shared for wider awareness of the systems and to promote sustainable construction.

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