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# Issues in Managing Construction Phase of IBS Projects

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**Abstract**

There are several issues in managing IBS construction projects which lead to delays, poor qualities and cost overrun. This paper aims to analyze the issues in managing the construction phase of IBS projects that reflects IBS as a non efficient implementation. The issues can be categorized into pre construction, construction and post construction phase. Majority of the issue is under the construction phase. Categorizing the issue will help to increase the contractor's understanding and help them to be prepared in handling the situation that they may encounter during the construction process.



*Keywords*: Industrialised Building System (IBS); construction phase; issues

## 1. Introduction

In Malaysia, the adoption of Industrialised Building System (IBS) can be tracked as early as in year 1960's. However, it is only becoming prominent lately, due to the rapid encouragement efforts made by the Malaysian Government. The method had proven to offer high quality buildings, timely construction completion and cost savings through standardization, specialization and mass production (CIDB, 2003a; Thanoon et al., 2003). Essentially, IBS can be defined as a process of producing building components in a large-scale production either on or off-site, transported or erected into a structure at the site with a minimum site work. During the construction phase, parts of the predicted benefits of IBS adoption are quality and productivity of construction, the reduction of unskilled workers and reliance on manual foreign workers, less wastage, less volume of building materials, speedier construction time, increased

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environmental and construction site cleanliness, reduced risk by improving health and safety, proper coordination and management. Despite the promotion of rigorous benefits in IBS adoption, industry stakeholders are still skeptical about the IBS usage since issues such as technical difficulties, design conflicts and skill shortages during the construction phase becoming the barriers.

Accordingly, in addressing a knowledge gap in construction level, this paper analyzes the issues in managing the construction phase of IBS projects that reflects IBS as a non efficient application in gaining its benefits. The issues are based on the Malaysian context and supported by worldwide literature. The identified issues will provide a better understanding and a clearer picture on problems that may arise during the implementation of IBS in Malaysia. The examination is through a critical review of available relevant literature on the system from various books and article. This study reviewed 50 existing literatures on IBS in Malaysia and worldwide. The reviewed does not limit to articles published in the peer-reviewed journals but also includes theses and books. In order to develop new findings, the limit of this research is from year 2000 to 2012.

## 2. Benefits of adopting IBS

Numerous benefits of adopting IBS had been reported by academicians around the world and becoming the driving forces to the construction industry players in deciding whether to use IBS or not (Pan et al., 2007a). The benefits of IBS adoption are summarized in Table 1 as follows:

Table 1. Summary of IBS benefits

| Benefits | Explanation |
|---|---|
| Cost and financial advantages | IBS offers cost saving through:<br>a) Earlier completion time (Kamar et al.,2010; Idrus et al., 2008; Pan et al., 2007; Alinaitwe et al., 2011).<br>b) Repetitive use of system formwork made of steel, aluminium, etc. and scaffolding (Thanoon et al., 2003).<br>c) Less wastage and the usage of building material (Idrus et al., 2008) .<br>d) Reducing site infrastructure and overhead (Kamar et al,. 2010).<br>e) Increased certainty – less risk (Pan et al., 2007) . |
| Construction speed | IBS construction process is governed by the speed of production and controlled environment of manufacturing facilities (Aburas, 2011), thus the need on fast delivery can easily be met by increasing the production capacity (C. Haas et al., 2000; Nawi et al., 2007). |
| Reducing labour | Malaysian government aims to reduce the using of foreign labour (CIDB, 2003). The using of IBS component, which is manufactured in centralized factory, automatically will reduce labour requirements at construction site (CIDB, 2011a). |
| Better quality | Better quality products can be produced with the adoption of IBS as it uses good quality components and involved numerous expertises throughout the process starting with manufacturing, installer, engineers, contractors and others (Kamar et al., 2010; Thanoon et al., (2003; Alinaitwe et al., 2011). |
| Health and safety measures | IBS application will improve site safety by providing cleaner and tidier site environment (Tam et al,. 2007; Pan et al., 2007; Rahman & Omar, 2006) as the site activities become minimum and indirectly reduce construction hazards (Alinaitwe et al., 2011). |
| Flexibility | IBS allows flexibility in architectural design, in order to minimize uniformity of repetitive facades. Simultaneously, the flexibility of different system used in IBS construction process produced own unique prefabrication method (Thanoon et al., 2003). |
| Waste minimization | All IBS components are manufactured from the factory, resulted in less wastage (Idrus et al., 2008; Kamar et al., 2010). |
| Improving productivity | The application of IBS, will overcome the problems of workers insufficiency which affected contractor's productivity (CIDB, 2010) (Kadir et al., 2005). At the same time it enhances productivity by removing difficult operation off-site and less site disruption (Arif & Egbu, 2010). |

These benefits have been a significant driver in IBS adoption to prevail the traditional construction skills shortage, speeding up the construction process, cost certainty and achieving a higher quality (Pan et al., 2007; Blismas & Wakefield, 2009). Accordingly, it attracted the government to initiate and promote the IBS usage in construction industry.

## 3. Generic issues in managing IBS in construction projects

Despite the advantages of using IBS in the construction projects, researchers had highlighted several problems (Kamar et al., 2012; Pan et al.,2012; Sadafi et al., 2011; Nadim & Goulding, 2010), which led to government's target in IBS application, is beyond anticipated level (Nawi et al., 2011). To what extent the full benefits of IBS materialize in the Malaysian construction is unknown. Listed below are the generic problems in managing IBS construction projects.

### *3.1. Enormous capital cost*

The most significant challenge to the adoption of IBS is higher capital cost (CIDB, 2010; Pan et al.,2004; Pan et al., 2007; Blismas & Wakefield, 2009). At the beginning, there is a requirement on large investment for setting up the plant, supplying machinery and mould, engineering consideration in dealing with the complexity of interfaces and expenditures of the transportation process (Qays et al. 2010; Haas & Fagerlund, 2002). The adopters also require a large volume of work to break even on the investment which means IBS needs a large scale of production in order to achieve economic viability (Pan et al., 2007; Hamid et al., 2008; Alinaitwe et al., 2011). Apart from that, a budget should be allocated for maintenance of machineries. Facing the inconsistency of volume demand resulted in lack of business continuity thus making the investment unsustainable and limiting interest on IBS.

### *3.2. Insufficient knowledge*

According to Rahman & Omar (2006), lack of knowledge and exposure to IBS technology is one of the factors that contribute to poor structural analysis and design of prefabricated components, thus its led to improper assembly due to difficulties during installation. Lack of knowledge of IBS in the industry is one of the reasons on delay of IBS take-up (Blismas & Wakefield, 2009) .

### *3.3. Component standardization*

One of the success factors in IBS usage is the standardization of components. To date the low components standardization prevents the same components to be used for other projects (Hashim & Kamar, 2011). Onyeizu et al., (2011) opined that architects, engineers and contractors regard standardization of building components as the key factor affecting IBS and design innovation. The effect of low standardisation will increase the initial cost due to the design cost and moulding which cannot be used for another project (Hamid et al., 2008).

### *3.4. Integration*

Nature characteristics of construction project, which, are fragmented, diverse and involve many parties led to the involvement of IBS contractors and manufacturer only after the design phase (CIDB, 2005). CIDB (2007) reported that the need of plan redesign on IBS components, which, incurred additional cost is due to lack of integration among relevant players. Further, Kamar et al., (2009) is in the opinion that the pre-caster, designer and contractor firm should be integrated as early as possible in order to ensure the success of IBS. Integration deficiency in IBS construction has led to ineffective communication and lacks understanding among the stakeholders (Kamar et al., 2010). On top of that, Nawi et al., (2007) and Kamar et al., (2009) highlighted that the fragmented nature of the construction industry requires contractors to be system integrator and process coordinator in managing the process from the production line to the site.

*3.5. Transportation*

As discussed by Haas & Fagerlund, (2002) among the challenges in managing IBS construction are transportation issue, which, revolve with the issues of size and weight limitations, route restrictions, permitting and the availability of lifting equipment. When the components reach the construction site, it requires additional lift planning. The complexity of lift, normally increases with the increase in level of IBS usage. Transportation consideration will give impact on construction schedules, site design, crane cost and availability of designing the plan itself.

*3.6. Coordination*

When selecting IBS as an option, it is necessary to understand the extensive coordination required prior to construction operations, for instances coordination of design, transportation, tracking, and installation to ensure successful implementation. Apart from that, adjustments in the work breakdown structure, terminology, drawings, progress measurement, scheduling for materials management and supply chain scheduling should also take into consideration. With the increased of coordination required for the construction operations, the needs of effective communication becoming vital for the distribution of information regarding decisions, designs, transportation requirements and schedules. At the same time, since construction projects involved with various project participants, it requires integrated involvement of these people, for instance through regular meetings (Haas & Fagerlund, 2002).

*3.7. On-site construction process*

The requirement of using skilled labor and machineries indirectly will incur the cost during the erection of IBS components. Additionally, the components itself, for instance concrete panels, are heavy and difficult to align, which, may lead to the problem of improper assembly, leakage and crack in the future (Rahman & Omar, 2006). Meanwhile, the connections also are not flexible enough to allow changes during mid-construction (Sadafi et al., 2011). According to Pan et al., (2004) site specifics or constraints also caused problems in the IBS construction process since IBS components required additional space for storage, mobilization and circulation of machines and equipments.

*3.8. Planning and implementation*

According to Kamar et al., (2009) IBS project needs good planning in the aspect of manufacturing, transportation and erection on site. The delay will cause severe impact to completion time and indirectly incurred the cost.

## 4. Issues in managing the construction phase of IBS projects in Malaysia

Poor management of IBS projects often led to many difficulties, which end up to project delays, unacceptable qualities and higher cost (Haas et al., 2000; Kamar et al., 2009; Poon et al., 2001; Rahman & Omar, 2006). The success of IBS implementation in the Malaysian construction industry is solely depending on the contractors who manage the processes involved in the IBS life cycle (Kamar, 2011). Apart of that, the commitment of contractor in managing the project is crucial to achieve maximum safety of that project (Ismail et al., 2012). The contractor should be competent and experienced in managing the construction activities (Lou & Kamar, 2012; Chan et al.,2004; Wong et al.,2003). Similarly, the contractor should take into consideration all the issues in their management practice in order to achieve success in the implementation of IBS projects.

Literatures have identified 28 issues commonly arises in managing IBS construction projects. Among of these issues are high initial cost, huge volume of work to break-even, lack of equipment and machinery, lack of testing facility and IBS components, requirement of skill labour, difficulties to apply changes, insufficient training on site levels, difficult to attract new workers to join the workforce and retrain them with new IBS skills and building defects. The identified issues are divides into 3 construction phases (Clements & Gido, 2012; Osman, 2006) namely:

- Pre-construction
  This phase includes the initiating and planning phase. The planning phase comprise of defining the project scope, identifying resources, developing a project budget and schedule and identifying risks.
- Construction
  Known as the performing phase where the project plan is executes, and work tasks are carry out to accomplish project deliveries and project objectives.
- Post construction
  This phase also means as closing phase to the contractor. The contractor will conduct the project evaluations, identifying and documenting lesson learned to help improve performance on future projects.

The discussion of these issues is to initiate more understanding for a contractor in managing IBS projects as per categorizations as follows:

### *4.1. Pre-construction phase*

In general, several scholars (Chong, 2006; Kamar et al., 2009; Nawi et al., 2007) had highlighted that the usage of IBS will offers cost saving, faster construction speed and improve the quality. However, a major issue in this phase is the initial capital cost which contractor needs to allocate and appropriately organize. The contractor requires to consider on investment of specialized equipments and machineries, training for human resources, transportation process, setting up prefabrication yard and etc. (Jaillon & Poon, 2009; Nawi et al., 2011; Qays et al., 2010). At the same time, such investment needs large volume of work to break even (Hamid et al., 2011; Hashim & Kamar, 2011). In the other words, it only can be achieved if there is a continuing demand for the product (Thanoon et al., 2003). On the other hand, despite the requirement to convert a conventional drawing into IBS drawing, which, will consume time, the process employed to construct facility will also influence the project duration (Blismas, 2008; Azman et al., 2011)As mentioned by Hamid et al., (2007) and Rahman & Omar, (2006) lack of knowledge in relation to the building materials and installation methods together with no standard design or guidelines on the systems has led to the low quality of final products. Other issues in relation to this phase are lack of integration between project team, one of the problems here is there was no early involvement of the contractor, the contractor usually involved after the design phase which makes them unable to contribute their opinion on the design and construction aspect of the system (Shukor et al.,2011). IBS needs a systematic planning throughout the project lifecycle in terms of design, manufacturing, assembly and other related process which generally regards as difficult by the contractors due to the nature of the construction industry, which, is fragmented, diverse and involve many parties (Kamar, 2011; Thanoon et al.,2003). Poor planning will reduce the contractor productivity and slow down the construction process (Hassim et al., 2009).

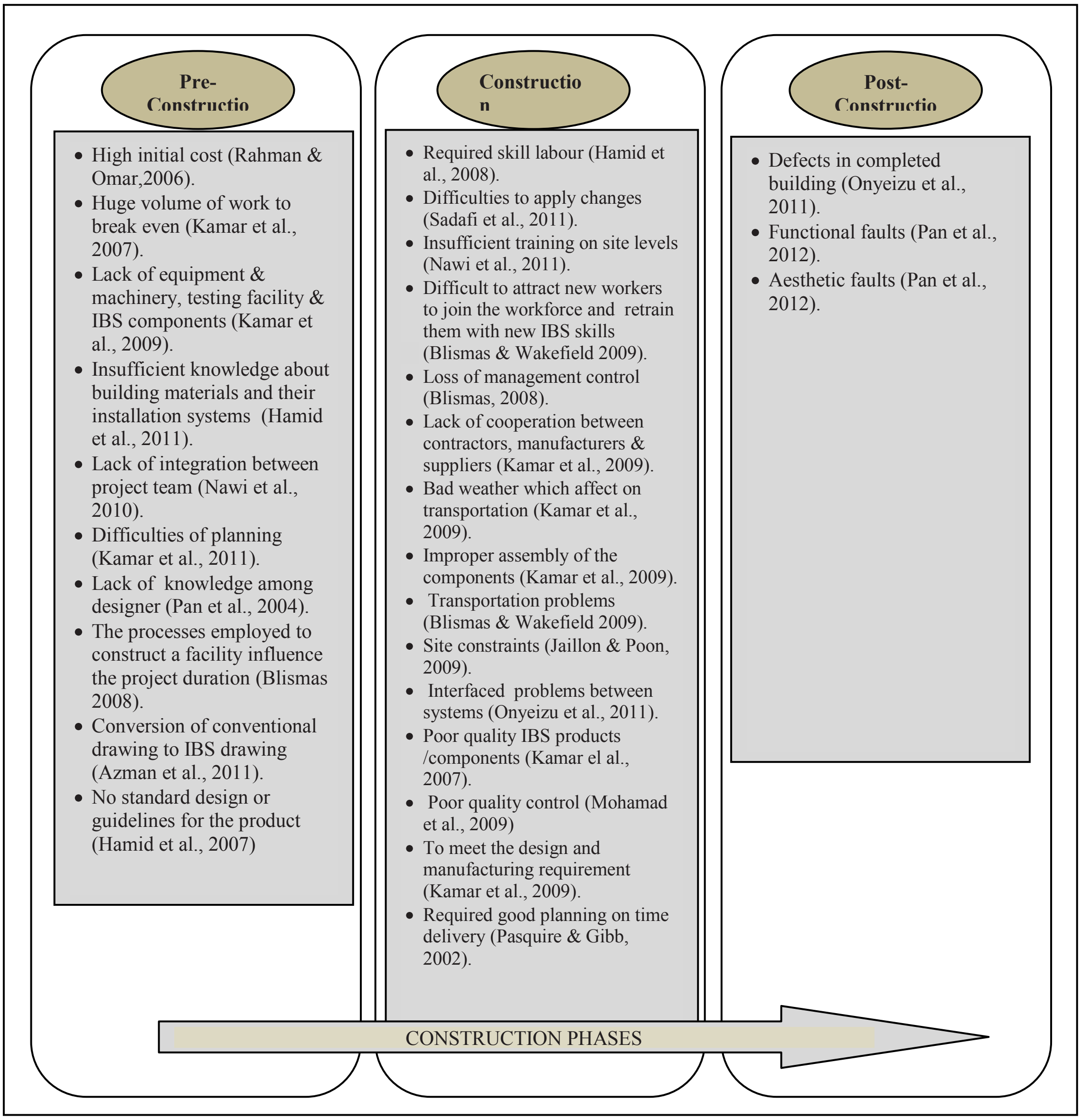


Fig. 1. Categorization of issues

### *4.2. Construction phase*

This is the phase where the process of installation and erection of IBS components is carried out at the construction site. As the aim of IBS implementation is to reduce the dependency of unskilled foreign workers, subsequently, IBS required specialist skill workers to accomplish the installation process which depends more on machine oriented skills (Hamid et al., 2008; Kamar et al., 2007). However, most of the available skill workers are still lack of appropriate technical skills and knowledge (Pan et al., 2004), and it is difficult to attract new workers and train them with new IBS skills (Blismas & Wakefield, 2009; Pan et al., 2004; Pan et al., 2007b). Deficiency in skills and knowledge resulted to improper assembly of the components (Kamar et al., 2009), which, will affect the end product qualities. Moreover, it requires more time and investment to provide intensive training to the workers (Nawi et al., 2011). On the other hand, the usage of the machine and equipment, faced the problems on limited movement around the site (Blismas et al., 2005). At the same time, it is difficult to obtain equipment and machinery to carry out the tasks (Kamar et al., 2007).

In essence, IBS components not only produced in the factory but also can be produced in a large scale at the construction site which will lead to cost savings in terms of transportation. However, due to the space constraint, the on-site casting yard cannot be realized (Jaillon & Poon, 2009). Practically, producing a large scale IBS components normally been carried out off-site which required transportation medium in shifting the components from the production site to the construction site. Great planning is crucial in estimating the delivery time of IBS components to ensure it is in-line with the preparation at the site. Otherwise, the components will expose to the risk of damage especially when the components are not properly stored. Damage to IBS components on-site will give greater implication to cost, time and process compared to traditional construction materials (Pasquire & Gibb, 2002). Other problems in relation to transportation are that the limit for large component due to items' mass, road widths, bridge load capacity and transport curfews (Blismas & Wakefield, 2009). Most of the IBS manufacturers and factory located in west peninsular Malaysia. Thus, it results to ineffective distance to a site, which located far from the manufactured location. Subsequently, incurred the transportation cost, especially if the site located in northern and east region (Chong, 2006). Weather problem can be eliminated once IBS method applied in construction operation (Thanoon et al., 2003). However, this benefit gained by the production of IBS in a factory only. Transportation and installation activities still affected by extreme weather condition (Kamar et al., 2009).

One of IBS characteristics is component standardization in building (Gibb & Isack, 2001), yet this characteristic has coupled with technical issues during installation such as low interfaces tolerances in between components (Blismas & Wakefield, 2009; Pan et al., 2007b; Pasquire & Gibb, 2002). Other problems as explained by Onyeizu et al., (2011) include interfaces between new and existing construction, joints between difference module or components and electrical connection between factory made product and site-installed. Therefore, the contractor requires to have more understanding in coordinating the complex interfacing issue, failure to deal with this complexity will reduce the quality of the completed building. On the other hand, Thanoon et al., (2003) stated that IBS is flexible in terms of design and construction, but Sadafi et al., (2011) highlighted that IBS usage faced the problem of the difficulties in applying changes in the middle of site work and over its life span.

Quality is a vital concern in construction which becoming one of the criteria in determining whether the project success or not. Improving quality is one of the benefits achieved by using IBS (Chong, 2006; Pan et al., 2007a; Pan & Goodier, 2012). However this benefit offset by poor quality of IBS components while reaching on-site (Kamar et al., 2007), this might due to the production fault, transportation and handling. At the same time, contractor faces with the difficulties during installation at the site in order to comply with the design and manufacturing requirement (Lou & Kamar, 2012). Therefore, to ensure this benefit materialize, it requires strict quality control and close monitoring during the process (Mohamad et al., 2009).Another issue that contractor need to consider is to enhance the cooperation with manufacturers and suppliers which is currently weak (Kamar et al., 2009), as IBS construction itself required close integration and cooperation among stakeholders (Hamid et al., 2011). Moreover, when large proportions of works are carried out off-site, the contractor has the potential for loss of management control (Blismas & Wakefield, 2009).

### *4.3. Post-construction phase*

The completed product during this phase portrayed the effectiveness of IBS implementation. However, there are still cases where building projects constructed using IBS contribute to poor qualities (Kamar et al., 2009; CIDB, 2010; Rahman & Omar, 2006). Amongst the factors that contribute to the poor quality of IBS buildings are defects which resulting from inadequate technical knowledge, shoddy workmanship and poor quality control which causes aesthetic and functional faults (Onyeizu et al., 2011; Pan et al., 2012). The defects include cracks, blemishes, moisture penetration, water leakage due to improper jointing and poor thermal insulation (Onyeizu et al., 2011). Defects during the handover period will cause further maintenance problems in the future (Wong et al., 2003). Thus, the benefits of IBS implementation in-terms of reduction in defects simultaneously producing quality building cannot be gained if the root of this issue is not properly overcome

## 4. Conclusion

Numerous benefits can be achieved by implementing IBS into construction projects. As promoted by IBS Roadmap 2011-2015, good quality design, speedier construction time and cost saving is the main attraction in implementing IBS. However, these ultimate benefits cannot be materialized if the issues in the construction phase being neglected. Literature research shows that there are 28 issues concerning of IBS project management in the construction process. The issues can be divided into three categories namely; pre-construction, construction and post-construction phase. Based on Figure 1, most of the issues that need critical attention by the contractor are under construction phase. The majority of the issue was in this category due to the involvement of many parties during the construction process. Besides that, construction phase usually has a longer duration compared to the other two phases, thus increase the number of issues arises. Categorizing the issues will help to increase the contractor's understanding and help them to be prepared in handling the situation that they might faced during the construction process. Properly manage the issues will further reduce difficulties such as delays, poor qualities of the final product and cost overrun.

This paper had provided an in-depth review of issues encounter during the construction phase of IBS projects. The identified issues will act as a basis and become helpful for contractors who implement IBS to determine difficulty and enable them to avoid potential risks. It is anticipates that the findings from this research will create awareness, assist contractors to understand issues arise in IBS construction project, increase the chances for successful implementation and serve as a guideline for future planning.

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