Journal of Engineering Science and Technology
Vol. 9, No. 4 (2014) 490 - 501

IBS SURVEY 2010: DRIVERS, BARRIERS AND CRITICAL SUCCESS FACTORS IN ADOPTING INDUSTRIALISED BUILDING SYSTEM (IBS) CONSTRUCTION BY G7 CONTRACTORS IN MALAYSIA

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Abstract

The industrialised building system (IBS) survey has become an essential tool for ensuring the IBS Roadmap (2003 to 2010) meets its goals and target. As part of the process review survey, it also records the trend achievement of Malaysia in the usage of IBS in the building construction industry. The first and second IBS surveys were published in 2003 and 2005, respectively. Afterward, the IBS Roadmap's mid-term review was conducted. The third and the most recent IBS surveys were conducted in 2008 and 2010, respectively. This paper aims to highlight a part of the IBS survey report in 2010, which has been conducted to measure the drivers, barriers and the critical success factors of G7 contractors in adopting IBS construction. G7 is a Construction Industry Development Board contractor grade that can apply tender without limit. The importance of this paper is that it guides the policy and implementation strategy of IBS by G7 contractors. The survey shows that the acceptance, adoption, and deployment of IBS in the Malaysian construction industry are still low and do not address the persisting problems, such as productivity, dependency on foreign workers and high level of construction wastage.

Keywords: Industrialised building system (IBS), Malaysia, Critical success factors, Contractors.

1. Introduction

The earliest industrialised building system (IBS) survey in Malaysia was conducted by the Construction Industry Development Board (CDIB) in 2003 to

study the awareness and usage of IBS in construction from the point of view of contractors G5 to G7. The second IBS survey was performed in 2005 to survey architects' opinion and acceptance on IBS. The IBS Roadmap's mid-term review in 2007 was conducted to gauge the state of IBS implementation and progress on the roadmap's recommendations. The third IBS survey was undertaken in 2008 to measure the acceptance of the construction industry (classes G7 to G4 contractors) towards the IBS system and the ranking of IBS benefits [1].

The IBS survey in 2010 was conducted to measure the drivers, barriers and the critical success factors of G7 contractors in adopting the IBS construction. The objective of the IBS Roadmap (2003 to 2010) was realised at the target deadline in 2010 [2]. The Roadmap was designed then by the IBS Steering Committee to ensure that the formulated IBS is applied to the construction industry in Malaysia. It also discloses the actions taken by the CIDB in ensuring the implementation of IBS in the construction industry. In 2011, a new roadmap for IBS (IBS Roadmap 2011 to 2015) that focuses on private sector adoption and capacity building was published. The results from the IBS survey in 2010 highlighted in this paper can be an indicator of the current state of implementation. These results also highlight certain the lessons learnt that can guide the implementation of the IBS Roadmap 2011 to 2015.

Based on the surveys conducted in 2003, 2005, and 2008 as well as the IBS Roadmap's mid-term review in 2007 (see Table 1), the initial take up for IBS was not as high as was first anticipated at this stage, particularly from the private sector. The adoption failed to obtain private sector buy-in. The IBS Survey 2003 states that only 15% of the construction projects used IBS in Malaysia [3]. The IBS roadmap's mid-term review in 2007 indicated that only approximately 10% of the complete projects used IBS in 2006 as compared to the forecasted IBS usage of 50% in 2006 and 70% in 2008, as projected in the roadmap [4]. The IBS survey 2008 commenced from June to December 2008. The ranking of IBS benefits were measured and listed from the most to the least beneficial: (1) minimal wastage; (2) cleaner environment; (3) less site materials; (4) reduction of site labour; (5) controlled quality; (6) faster project completion; (7) neater and safer construction sites; and (8) lower total construction costs [5].

All the respondents of class contractors (G7, G6, G5 and G4) have strong opinion, as shown in the *t*-test of the average percentage difference, with 0.63% in IBS actual use (problem faced in using IBS), 3.98% in IBS awareness, and 4.06% in IBS actual use (promotion of IBS by the government via CIDB). However, the percentage of those disagreeing with the perceived IBS usefulness is relatively low (12.74%). Meanwhile, 10.06% perceived ease of IBS usage and 6.54% with the actual use of IBS. These figures show that all the contractors face common problems in using IBS. However, they are highly aware of the importance of IBS in the construction industry and thus should overcome the problems in using IBS. The respondents appreciate the role of CIDB in promoting IBS in the Malaysian construction industry. G7 contractors strongly agree on the usage of IBS. Their acceptance of the IBS system is higher compared with other classes of contractors (i.e., G6, G5 and G4) based on the *t*-test results of IBS actual use in the context of benefit, perceived ease of IBS use and perceived IBS usefulness.

Table 1. IBS Surveys in Malaysia Conducted by Construction Industry Development Board (CIDB) from 2003-2008.

Name of the Survey	Year	Objective	Output
IBS Survey 2003 (CIDB, 2003)	2003	To study the awareness and usage of IBS in construction from the point of view of contractor G5 to G7	Only 15 % of construction projects used IBS in Malaysia. 54 % want to use IBS in the future. Most popular IBS is steel roof trust (55%).
IBS Survey 2005 (CIDB, 2005)	2005	To survey architects' opinion and acceptance on IBS	Only 30 % of architect is in favor of IBS design. 70% of architects lack of knowledge on IBS. 34% want to use IBS in the future
IBS Roadmap's mid-term review (CIDB, 2007)	2007	Mid-term review of IBS Roadmap 2003-2010 to gauge the state of IBS implementation and progress on the roadmap's recommendations.	Only 10% of the complete projects used IBS in the year 2006 as compared to forecasting IBS usage of 50 % in 2006 and 70% in year 2008 as projected in the roadmap
IBS Survey 2008 (Majid et al., 2011)	2008	To measure the acceptance of construction industry (class G7 – G4 contractors) towards IBS system and to produce ranking of IBS benefits to contractors	The ranking of IBS benefits listed from the most beneficial to the least beneficial are (1) Minimal wastage, (2) Cleaner environment (3) Less site materials (4) Reduction of site labour (5) Controlled quality (6) Faster project completion (7) Neater and safer construction sites and (8) Lower total construction costs.

The surveys (2003, 2005, 2008 and IBS Roadmap's mid-term reviews) indicated that the availability of inexpensive foreign labour, which offsets the cost benefit of using IBS, is the root cause of the slow adoption. The availability of inexpensive foreign labour also relates to the sheer cost of investment and the inadequacy of market size.

Small contractors are already familiar with the conventional system, and for them, the technology suits well with small-scale projects. Therefore, they are unwilling to switch to a mechanised system. In this sense, small contractors lack financial backup and are unable to set up their own manufacturing plants because it involves extremely intensive capital investment [6].

The surveys (2003, 2005 and 2008 and the IBS Roadmap's mid-term reviews) highlighted that the idealism, processes, management and skill sets of IBS are different from those of the traditional method. Lack of knowledge in IBS construction technology is equally important [7]. In several cases, building projects were awarded and constructed using IBS system but suffered project delays and bad qualities [8]. This condition has left the industry with noticeable difficulties when using IBS. As a result, the industry has become reluctant in accepting IBS, except when it is required by the clients.

A wider understanding of the characteristics and the aspects involved in IBS is needed. The design and manufacturing should be managed differently from the

traditional way because IBS is different and needs a different mindset along with the right environment [9]. Therefore, in formulating and implementing the IBS Roadmap 2011 to 2015, rethinking the old processes is critical if the industry intends to move forward. A consensus of opinions has been reached, which states that IBS is best handled as a holistic process rather than simply a collection of technological solutions. The approach requires total synchronisation on construction, manufacturing and design processes. Emphasis should be given to rationalisation, standardisation, repetition, collaboration, supply chain partnering and more effective planning and project management [10]. The survey provides basis on understanding the preferable system, drivers, barriers, and the factors that are critical to IBS in Malaysia as perceived by the contractor, which result in the success or failure of the IBS implementation.

This paper aims to highlight a part of the IBS survey 2010 under the fifth review of the IBS awareness in Malaysia. The main objective of this paper is to measure the drivers, barriers and the critical success factors of G7 contractors in adopting IBS construction based on their past experiences and their general perception. Contractors have adopted the critical success factors principle to use IBS where it is able to improve our understanding on the preferable system, drivers, and barriers in using and maximising the benefits and values offered by IBS. This paper represents the quantitative survey performed among contractors in the G7 companies in Malaysia to determine the level of IBS usage and the factors associated with it.

2. Survey Objective, Methodology and Sampling of IBS Survey 2010

Contractors are the stakeholders who address project management and issues of time, cost and quality related to construction on a daily basis. They are responsible for the means and methods used in the execution of the construction of the project in accordance with the contract documents. Contractors are usually responsible for supplying the construction project with material, labour, equipment, and services.

In many cases, the main contractors delegate portions of the contract work to the sub-contractors. The total number of IBS contractors in Malaysia registered with CIDB is 894; 334 of them are G7 contractors who represent the largest class of contractors involved in IBS [11]. Contrary to popular belief that IBS is client-driven, recent studies have revealed that contractors in Malaysia also have considerable influence over the developer's decision as to whether they would use IBS or not. As such, contractors' perspective on IBS needs to be scrutinised. An effort towards total industry adoption of IBS from convention largely depends on the readiness and maturity of the contractors to coordinate the processes involved in the IBS life cycle. In numerous cases, the use of IBS has failed to achieve total satisfaction and could actually be less productive than the conventional method [4, 11]. IBS has been previously associated with low-quality buildings, leakage, abandoned projects, and other drawbacks delivered by contractors.

The objective of this contractors' survey is to identify the most popular IBS system and the drivers and barriers in the use of IBS. G7 contractors were chosen as the survey sample because of their influence on the course of direction of the construction industry. In addition, G7 contractors comprise the largest group of CIDB's contractors classification registered as IBS contractors. G7 contractors can also put up tender and implement large projects. The use of IBS by G7 contractors

will create a large demand and establish a new supply chain; however, they need to establish capital investment to implement IBS. G7 contractors employed a large number of workforce, sub-contractors and specialists in their projects. Based on their past experiences, the G7 respondents were asked to identify the critical success factors in their IBS implementation. In this survey, 200 postal questionnaires were sent to the G7 contractors registered with the CIDB and listed in the Orange Book (Malaysian IBS Directory) [12]. A change from the conventional method to IBS will influence others and make a significant impact to the industry as a whole.

Out of the total sample of contractors, 18.5% (N=37) participated in this study via mail; their completed questionnaires were received and analysed. The highest number of respondents (53%) consisted of senior managers involved in IBS, which is favourable for an opinion survey analysis, given that the respondents are more likely to portray the actual company direction. Project managers comprise the second highest number of respondents (16%), followed by project engineers (6%). The respondents are professionals, which is beneficial and relevant to the survey. In terms of experience, 64% of the respondents have more than 15 years of experience in the construction industry. Meanwhile, 30% of respondents have at least 5 years of experience. This finding is another effective indicator that the respondents are highly qualified to answer the survey questions

3. Survey Analysis and Discussion

The Cronbach's alpha obtained in this survey is 0.86, which is higher than 0.80. This proved that the result is reliable [13]. Based on Fig. 1, the most important drivers for contractors to use IBS are achieving high quality, gaining speed of construction, minimising onsite duration, client demand and addressing skill shortage, with results of 13.5%, 13%, 10.4%, 8.7%, and 7.4%, respectively. In contrast, factors such as energy saving (1.3%), building's regulation (2.2%) and dealing with adverse weather condition (3%) are less important to the contractors.

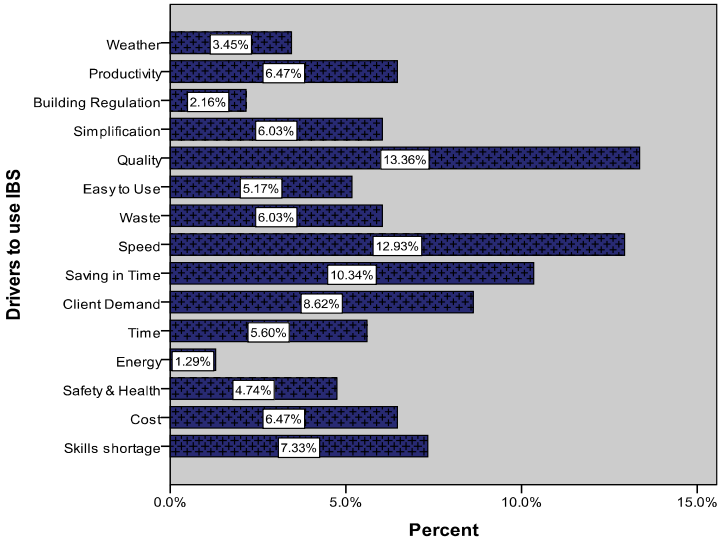

Fig. 1. Driver to IBS as Perceived by Malaysian G7 Contractor.

Figure 2 shows that the most significant barrier restricting the use of IBS for contractors is higher construction cost (14.3%), followed by high capital investment (11.5%), difficulties in achieving economies of scale (9.3%), inability to freeze design early and complex interfacing (7.7%) and lack of knowledge in IBS (7.7%). Other factors related to the level of IT, building regulation and code and standard were not considered relevant by the contractors, as shown by the results of 1.1%, 1.7% and 1.7%, respectively. The survey reveals that the factors responsible for the contractors' lack of acceptance toward IBS are rarely purely technical in origin. They are more related to the organisational strategy and soft issues that underpin the capability of organisations to successfully implement IBS. This finding led to the identification that IBS is best handled as a holistic process and requires total synchronisation on construction, manufacturing and design processes.

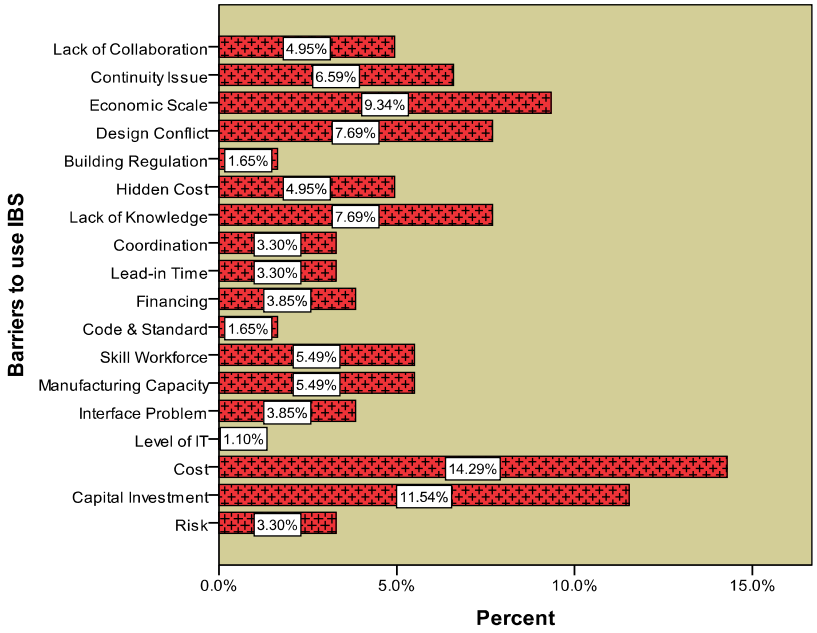

Fig. 2. Barriers to IBS as Perceived by Malaysian G7 Contractor.

In addition, Table 2 shows the respondents' view regarding the importance of each potential success factor based on a five-point Likert scale (1 – least important, 2 – less Important, 3 – important, 4 – very important and 5 – most important). Based on statistical analysis, the mean value for all of the factors were >3.0, indicating that all of the factors listed are important to the implementation of IBS. Vision and commitment from the board management is the most important factor that determines the success of IBS, followed by early decision to use IBS and early assembly of the project team. Effective communication, site management, logistics and machineries and business and finance are also considered as important by the contractors. The contractors also regard factors such as technology and capability, training and education and IT as less important. The results of this survey will assist new contracting organisations in adopting IBS.

Table 2. The Critical Success Factors (CSFs) – Ranking.

Descriptive Statistics	N	Mean	Std. Deviation
Top- Down Vision & Commitment	37	4.35	0.676
Early Decision to Use IBS	37	4.30	0.878
Early Assemble of Project Team	37	4.24	0.796
Effective Communication	37	4.19	0.569
Site , Logistic & Machineries	37	4.19	0.660
Business & Finance	37	4.19	0.877
Process Coordination	37	4.11	0.614
Competent Workforce	37	4.03	0.833
Planning & Scheduling	37	4.00	0.707
Design Process	37	3.95	0.524
Management of Supply Chain	37	3.86	0.751
Continues Improvement	37	3.78	0.672
Partnering and Alliance	37	3.78	0.750
Demand and Volume	37	3.76	0.723
Organisation Knowledge	37	3.76	0.683
Information Technology (IT)	37	3.70	0.618
Training and Education	37	3.68	0.669
Technology & Capability	37	3.62	0.924
Valid N (list wise)	37		

The survey analysis and discussion are as follows:

- IBS improves quality, productivity, and efficiency owing to the use of factory-made products. It also reduces the possibilities of poor workmanship and lack of quality control, as stated by G7 contractors. The final IBS products are normally significantly superior compared with the conventional work, given that the former are produced under a rigorously controlled condition. Before IBS products are erected into the structure, they need to be inspected prior to the complex shapes and finishes, and any sub-standard components are rejected. Thus, IBS products are highly concerned on the good quality of surface finishes where the joints section is the only part to be grouted, eliminating the requirement of plastering.
- The reduction of construction building time is one of the key successful drivers to use IBS. The usage of standardised IBS components and simplified construction process enables the faster completion of projects compared to the conventional method [14]. It also builds faster because it cuts down the duration of work by reducing onsite activities and the number of trades on-site by using parallel approach on-site and manufacturing.
- According to the G7 contractors, the number of labour force required in IBS is considerably lower than that required in the traditional method; thus, IBS offers significant savings in labour and material cost [15]. However, the workers involved in IBS should be trained as skilled workers because IBS workers would be markedly more quality-conscious than the unskilled labourers who perform manual jobs in the conventional construction sector. IBS also alleviates the issue of shortages of skills in the construction industry because all the construction elements are fabricated at the factory. IBS eliminates the extensive use of carpentry work, bricklaying, bar bending and manual job on-site.

- IBS has been approved and used in the UK and Australia and is a cheaper method of construction as compared to the conventional method [16]. The savings come from the lesser number of workers and undercover the entire life costing of the building. Indirect cost savings occur because of the faster delivery of buildings, whereas direct cost savings come in the form of material, construction overhead and reduction in the use of scaffolding and other temporary support, as compared to onsite construction.
- Meanwhile, the limited take up of IBS among Malaysian G7 contractors can be attributed to the sheer cost of investment and the inadequacy of market size [8]. Since the Asian financial crisis in 1997 and the global recession in 2008, large investments in central production plants have become uneconomical. Relatively, high transport and overhead cost virtually eliminates the potential gain achieved through industrialisation. With the current low demand and low standardisation of IBS components, the initial usage of IBS would undoubtedly increase the total material costs of the projects although it ultimately lowers the total construction costs in the long run. Given that profit is the main motivation for contractors, an increase in take up rates will only materialise when the overall prices of IBS components are reduced [8].
- Moreover, the lack of investment on heavy equipment and mechanise construction system because of high capital investment could hamper the adoption of IBS [14]. Heavy capital cost involved in IBS will result in the contractors' insufficient capacity to secure projects [8]. Contractors thus require several forms of government intervention and assistance, such as award and provision of large-scale projects, that would justify the capital investment required to adopt and deploy IBS. Several contractors seek large design and building contracts from the government. Large design and building contracts will enable the successful development of unique technical capabilities and present innovation opportunities in IBS, which otherwise would be almost an economically inappropriate choice.
- Lack of experience, technical knowledge and skilled labour are barriers to successful IBS adoption. Poor human capital development on IBS will affect not only the contractors but also the entire supply chain [7]. Familiarity with the IBS concept and its benefits is vital to its success because IBS requires a different approach in construction.
- The most important critical success factors identified are top–down corporate vision, early decision to use IBS and early assembly of project team. The least important critical success factors are development role, training and IT. Therefore, policy makers, such as CIDB, should convince the top management of companies and the CEOs regarding the benefits of IBS.
- According to Kamar et al. [8], several G7 contractors invest in their own system and own their prefabrication yard. Nonetheless, a general consensus among practitioners is reached, which states that IBS needs mass production to achieve economic viability. However, currently, continuity of production cannot be assured in Malaysia, thus limiting the interest on IBS. Producing IBS components requires volume and economy scale of production. Moreover, despite the mandatory adoption in the public sector, the private sector clients still exhibited lack of support and slow adoption, thus creating imbalance and unsustainable demand. This condition is due to the lack of

assessment criteria set by the approving authorities as well as policies and incentives to urge the developers and private sector clients to use IBS.

4. Conclusions

The Malaysian government has encouraged the use of IBS to improve construction practices and modernise the industry. However, to change from the conventional practice to IBS is indeed an onerous task.

Despite the many theoretical and practical advantages of IBS, the acceptance, adoption and deployment in the Malaysian construction industry are still low and do not help address the persistent problems, such as low productivity, dependency on foreign workers and high level of construction wastage. Nevertheless, industrialisation through the use of IBS is encouraged. The present limitations and weaknesses of the system will become the barriers for successful adoption.

Generally, IBS would provide the solution on cost, labour and time-related constraints. However, the construction process is extremely complex because it involves the completion of buildings that combine different types of technology, materials, and parties that will hamper the adoption of IBS. The number of contractors in Malaysia who are specialists in IBS and can undertake IBS jobs is still limited. The contractors' readiness, even that of large G7 contractors, to embark in IBS is still questionable. IBS contractors, particularly G7 contractors, should take a lead in IBS. They should deploy highly innovative IBS, including the adoption of robotics, automation, and mass-customisation. They should embark and invest in technology and develop human capital.

To compete with construction companies in the global market in the future, their practise should be developed and enhanced by adopting effective processes in IBS and creating value-added in the complementary industries (e.g., building and construction materials, tooling, heavy equipment and machinery). Therefore, Malaysian G7 contractors might need to consider creating an IBS 'economic cluster' to boost this industry by developing partnerships with the government and the private sector when and where it is needed. This approach will help create a new environment in which IBS can promptly flourish and will also enable Malaysian IBS to be globally competitive.

5. Recommendations

The new roadmap (IBS Roadmap 2011 to 2015) focuses on the adoption of IBS in the construction projects of the private sector. The results and analysis from this paper generated several recommendations to encourage their participation, which are as follows:

- A vendor development programme modelled along the lines of the development of the national car industry should be established to target the delivery of building components for the construction to support G7 contractors in Malaysia. The vendor program is to be accredited by existing government agencies, which can provide a vetting process that can guarantee not only consistent quality but also the achievement of structural capacity, fire rating, and other requirements. The selected vendor are to be provided

with training, seed capital, components design and a selected private sector consultant to start up production factories. The location of this vendor's manufacturing plant should be in the areas with available labour. Based on educated assumption, the expected investment requirement of RM 1.25 million is considered feasible for small and medium-sized enterprises (SMEs) and as well as contractors displaced by the new technology. A system is to be developed such that the building component accredited will be given green lane approval to remove technical and non-technical legislation that may hinder the implementation of the new technology. The government can help by conducting market research to ascertain market opportunities to the vendors. The vendors also need inventory management consultancy and advice as well as the development of improved tools and infrastructures required for location of manufacturing plant.

- To encourage participation from the private sector, one of the steps that must be taken in coordinating the IBS industry is to develop and enhance the method of identifying targeted market for IBS. As such, the CIDB should take the initiative of developing a detailed market selection that will facilitate the identification of targeted market and provide assistance in addressing the needs and enquiry of prospective local construction companies that intend to venture to IBS. The selection matrix could be based on the following:
  i. Opportunities (availability of projects);
  ii. Chances of securing a project;
  iii. Business environment;
  iv. Funding- whether the projects are government-funded, multilateral agency-funded or privately funded;
  v. Level of risk, ranging from security risk to infrastructure risk; and
  vi. Ease of entry and exit.
- From a wider perspective, the industry and government indicate an acceptable level of willingness to take things forward. However, companies are reluctant to take risks, which is mainly related to the unstable market, hence the lack of investment. In this context, the contractors might need to consider creating an IBS 'economic cluster' to boost the industry by creating partnerships with the government and the private sector when and where it is needed. This approach will help create a new environment in which IBS can promptly flourish and will enable Malaysian IBS to be at par with those of other countries. Economic clusters refer to all necessary components required to obtain IBS off the ground. These components could include (and this is not an exhaustive list) the following:
  i. IBS association to create 'one voice' for the industry and thus better define and communicate their needs. This cluster could also undertake the role of lobby group for IBS;
  ii. Promote design and manufacturing as the core of the industry;
  iii. Develop SMEs to create the specialised supply chain to the core business;
  iv. Partially finance SMEs to establish the supply chain. Special housing finance– a special 'mortgage' facility to help people buy the produced units, thus creating the market;

v. IBS Regulatory Unit– to advise government and industry on new and adjusted regulations to jump start this industry;
vi. Develop and promote building information modelling;
vii. Develop new materials and technologies for IBS; and
viii. Facilitate a joint venture with semi-government bodies or government-linked companies to develop housing using IBS systems and joint ventures between local and international IBS contractors.

Although the recommendations may seem broad, a strategy that could coordinate many of these aspects at the national level can be formulated. Government organisations, such as the IBS Centre of CIDB could facilitate such a strategy to support the IBS Roadmap 2011-2015.

Acknowledgement

The authors wish to thank Prof. Mustafa Alshawi (University of Salford), Construction Industry Development Board (CIDB), Universiti Pendidikan Sultan Idris, Universiti Utara Malaysia, IBS Centre Malaysia and Construction Research Institute of Malaysia (CREAM) for supporting the IBS research. This paper is also part on IBS Roundtable Workshop series organised by Construction Research Institute of Malaysia (CREAM).

References

1. Majid, T.A.; Azman, M.N.A.; Zakaria, S.A.S.; Yahya, A.S.; Zaini, S.S.; Ahamad, M.S.S.; and Hanafi, M.H. (2010). The industrialised building system (IBS), Survey report 2008- Educating the Malaysian construction industry. *Second International Conference on Computer Research and Development, IEEE.* Kuala Lumpur, Malaysia, 615-619.
2. CIDB, (2003). Industrialized building system (IBS) roadmap 2003-2010, Construction Industry Development Board (CIDB), Kuala Lumpur.
3. CIDB (2003). IBS Survey 2003, Construction Industry Development Board (CIDB), CIDB Publication, Kuala Lumpur.
4. 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* (*MCRJ*), 2(1), 1-11.
5. Majid, T.A.; Azman, M.N.A.; Zakaria, S.A.S.; Yahya, A.S.; Zaini, S.S.; Ahamad, M.S.S.; and Hanafi, M.H. (2011). Quantitative analysis on the level of IBS acceptance in the Malaysian construction industry. *Journal of Engineering Science and Technology* (*JESTEC*), 6(2)**,** 179-190.
6. Rahman, A.B.A.; and Omar, W. (2006). Issues and challenges in the implementation of IBS in Malaysia, *Proceeding of the 6th Asia-Pacific Structural Engineering and Construction Conference (ASPEC 2006)*. Kuala Lumpur, Malaysia.

7. Kamar K.A.M.; and Hamid, Z.A. (2011). Supply chain strategy for contractor in adopting industrialised building system (IBS). *Australian Journal of Basic and Applied Sciences*, 5(12), 2552-2557.
8. Kamar, K.A.M.; Hamid, Z.A.; and Alshawi, M. (2011). Industrialised building system (IBS) in Malaysia. Construction Research Institute of Malaysia (CREAM) Publication, Kuala Lumpur.
9. CIDB (2005). IBS Survey 2005: Measuring the Perspective of Architect, Construction Industry Development Board (CIDB), CIDB Publication, Kuala Lumpur.
10. CIDB (2007). IBS Roadmap mid-term review, Construction Industry Development Board (CIDB), CIDB Publication, Kuala Lumpur.
11. CIDB (2010). IBS Info 2010, Construction Industry Development Board (CIDB), Malaysia, Issue 1.
12. Orange Book (2009). IBS manufacturers/distributors/ suppliers and onsite manufacturers directory. Volume 3, Construction Industry Development Board (CIDB).
13. Leontitsis, A.; and Pagge, J. (2007). A simulation approach on Cronbach's alpha statistical significance. *Mathematics and Computers in Simulation*, 73, 336-340.
14. Azman, M.N.A.; Majid, T.A.; Ahamad, M.S.S.; and Hanafi, M.H. (2011). A study on the trend of the use of IBS components and the setting UP of IBS manufacturing factories in the Malaysian construction industry. *Malaysian Construction Research Journal,* 9(2), 18-30.
15. Kadir, M.R.A.; Lee, W.P.; Jaafar, M.S.; Sapuan, S.M.; Ali, A.A.A. (2005). Construction performance comparison between conventional and industrialized building systems in Malaysia. *Emerald, Structural Survey*, 24 (5), 412-424.
16. Azman, M.N.A.; Ahamad, M.S.S.; Majid, T.A.; and Hanafi, M.H. (2010). Perspective of Malaysian industrialised building system on the modern method of construction. *The 11th Asia Pacific Industrial Engineering and Management Systems Conference*. Malacca, Malaysia.