Creative Construction Conference 2016

Decision Making in Reconstruction Phase after War

Sonia Ahmed[1], Petr Dlask[1], Stanislav Vitásek[1], Bassam Hasan[2],
Madonna Besharah[2], Neil Eldin[3]

[1] Department of Economics and Management in Civil Engineering, Faculty of Civil Engineering, Czech Technical University, Thákurova 7, 166 29 Prague , Czech Republic
[2] Department of Construction Engineering and Management, Faculty of Civil Engineering, Tishreen University, Lattakia, Syria
[3] University of Houston, College of Technology, Houston, TX, USA

Abstract

Most segments of Syrian society have been affected by the results of the current war, and perhaps the most important and serious result is the unbalanced demographic distribution of the population. Syria is concerned about how to put the integral strategy for the process of reconstruction of the totally and partly destroyed areas. This strategy will be realized by putting plans for the production of an integrated map, which includes an initial perception of all communities within small or medium residential cities, with all commercial, industrial, agricultural and tourist events, rather than regulatory and non-regulatory areas which currently have become destroyed and unfit for restoration and housing.
In the stage of the housing plan, researches were done in order to assess the reality of the construction of buildings in Syria, compared with the concepts of the industrial building system (IBS), to evaluate the factors affecting this industry, and proposals of applying it in the reconstruction stage. the results were as following: cast-in-place concrete in the case of the reinforced walls got 13.1%, while in the case of the framework structure it was 34%, and templates tunneling 64%, composite order (pre-cast and Cast-in-place concrete) 61%, composite order (concrete and metallic) 67.25%, and the pre-cast concrete from 82% up to 86%. This research has also arranged the priority use of technical systems in construction in Syria using the method of AHP (Analytic Hierarchy Process), the advanced technology system (pre-cast concrete) was in the first place with 39.4%, with knowledge that it faces significant challenges in spite of its inevitability as a strategic decision in finding solutions to the problems of housing and reconstruction.

Keywords: Construction industry; decision making; industrial building system IBS; modern building systems; war

1. Introduction

Construction industry forms an evolutional orientation for construction sector, which is considered one of the important economic sectors, in terms of its role in the formation of fixed capital and gross national product, and the magnitude of its employees [1]. The world has seen a significant expansion in the field of building and construction in the aspects of technology and productivity, but this industry is currently facing unprecedented developmental pressures in our country as a result of the lack of resources and the rising prices of raw material and the instability of environmental factors surrounding it. This is what prompts us to think about the system to frame the industry in order to evaluate it and make advancement towards the best, in order to achieve the requirements of sustainable development. The advancement of the construction sector towards the foundations of the construction industry requires the use of developed technological and administrative systems, compatible and in harmony with the architectural and constructional and technical systems for buildings so that they can get the product within sophisticated modern standards. Therefore, and due to the magnitude of the housing crisis and the deficit in securing the required modules, speed factor become an urgent need [2].

1.1. Research methodology:

- Review of previous studies about the construction industry and modern techniques used.
- Assessment of the reality of the Syrian construction experience and measurement of the *IBS* degree for the Syrian construction projects.

- Using a questionnaire to find out the most important factors affecting the construction industry and the extent of the current application and the importance of development in the future and analyzing the results of the questionnaire using the *SPSS* program.
- Determination of the priority to choose one of the technical systems used for construction in Syria using the Expert Choice program.

1.2. Benefits of adopting IBS:

The questionnaire and field survey showed that in despite the promotion of benefits in *IBS* adoption, the industry stakeholders and contractors are still sceptical about the *IBS* usage since issues such as technical difficulties, enormous capital cost, design conflicts and skill shortages during the construction phase represent? The barriers. Accordingly, in addressing a knowledge gap in the construction level, this paper has tried to explain the benefits of using *IBS* components. 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 [3]. The benefits of *IBS* adoption are summarized in Table 1 as follows:

Table 1. Summary of IBS benefits.

Benefits	Explanation
Cost and financial	IBS offers cost saving through: - Earlier completion time (Kamar et al.2011; Pan et al., 2007). Repetitive use of system formwork made of steel, aluminium, etc. (Thanoon et al., 2003; Besharah et al., 2015). - Less wastage (Idrus et al., 2008). - Reducing site infrastructure and overhead (Kamar et al., 2011). - Increased certainty less risk (Pan et al., 2007.
Reducing labor	The using of foreign labour (Jabar, 2013). The using of IBS component, which is manufactured in centralized factory, automatically will reduce labour requirements at construction site (CIDB, 2010).
Better quality	Better quality products can be produced with the adoption of IBS as it uses good quality components and involved numerous expertise throughout the process starting with manufacturing, installer, engineers, contractors and others (Kamar et al., 2011; Thanoon et al., (2003).
Health and safety measures	IBS application will improve site safety by providing cleaner and tidier site environment (Pan et al., 2007; Rahman & Omar, 2006) as the site activities become minimum (Besharah., 2015).
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 (Kamar et al., 2011).
Improving productivity	Productivity (CIDB, 2010; Kadir et al., 2006). At the same time it enhances productivity by removing difficult operation off-site and less site disruption (Arif & Egbu, 2010).

Source (author and Izatul laili Jabar et al, 2013)

1.3. Previous studies

Defined [8] *IBS* as the components' manufacturing, assembling, transporting, and placement construction using minimum additional work possible inside or outside the site. While the Construction Industry Development Board (CIDB) in Malaysia defined IBS as a building system where components being manufactured in the factory or off-site, then developed and assembled into a structure with a minimum of extra work at the site [10]. [14] Defined the IBS as an integrated manufacturing and building process, organized and planned well to achieve efficiency in the management, setup and control of resources used and support the activities and results using sophisticated components. There are different classifications of *IBS* according to [4] depends on: materials, processes and systems. It is important to develop a clear vision for different types of construction systems and modern techniques used that contribute to get the IBS and are an integral part of it. Generally, there are four types of building regulations in accordance with the Badir-Razali Building System Classification which are: traditional building systems, cast in place, pre-made, and composite [15]. Each of the construction systems is represented in accordance to their own construction methodology, and its advantages in additions in construction technology, and the engineering and functional composition [5] as shown in Figure 1. The different templates systems offer a wide range of concrete construction solutions that can be selected to suit the required development needs [16].

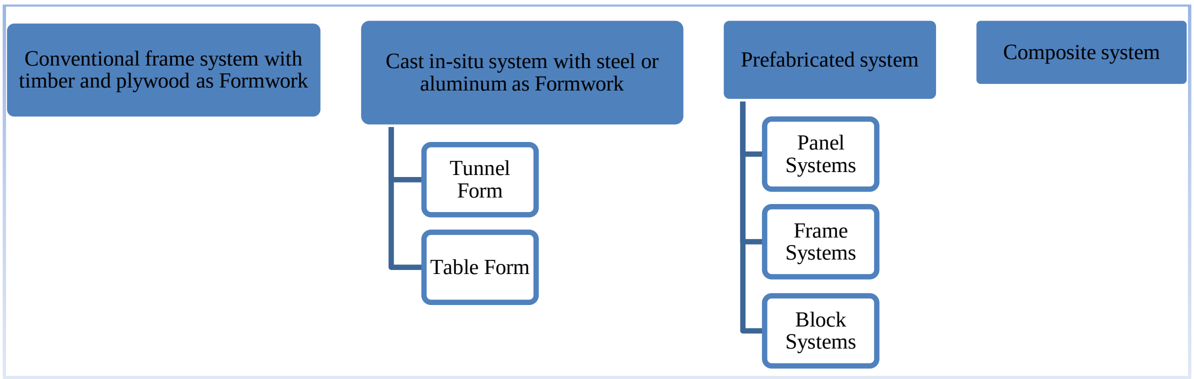

Fig1. Types of Building Systems (Source: author with using [5])

2. Results and discussion

Assessment of the level of *IBS* for the executive solutions patterns used for buildings in Syria:

2.1. Description of implementation modalities in Syria:

The dominant pattern of systems implemented in Syria is the using of templates of woody tambourines in the implementation of building structures (columns and walls and slabs cast in place), and there are less cases of using templates of small panels, or large panels of slabs and walls, and some cases of the use of tables templates, and tunnelling templates that are used for walls and ceilings. The construction experience in Syria refers to the use of pre-cast for the construction of residential suburbs, also the use of composite implement (cast-in-place and pre-cast) in some partial solutions in construction. A review of the Syrian experience in the evaluation of some performance indicators (time, quality, and cost) refers to a low level of these indicators [17]. The proposed system to assess the level of the construction industry in Syria *IBS* is a systematic and structured evaluation system; it can be used to measure the amount of using the *IBS* appropriately. Among the criteria adopted to measure the IBS is the measurement of the Construction Industry Development Board in Malaysia (CIDB) which is an important criteria with clear scientific methodology that supports our adoption of this approach for measuring the construction industry [10].

2.2. *Principles applied to evaluate the construction industry (PRINCIPLES OF IBS SCORE):*

The system of calculation of the *IBS* points focuses on several features of the construction specifications, such as using pre-cast components, production of components off-site, the use of standardized components, and the repetition, in addition to the design using the concept of consistent units. The method of determining *IBS* points is designed to be simple but scientific and effective. Points are awarded on the basis of *IBS* transactions of the components of structure and walls, and taking into account the contribution of repetition proportion in the design in total points. It should be noted that the maximum points for *IBS* of the building is 100 points are calculated according to the equation (1), the formula according to [10], *IBS* calculation formula:

$$IBS = 50\sum\left[\frac{Qs}{Qst}Fs\right] + 20\sum\left[\frac{Qw}{Qwt}Fw\right] + S \tag{1}$$

Qs: Construction area of a structural system.
Qst: Total construction area of building.
Fs: *IBS* Factor for structural system.
Qw: Length of a wall system.
Qwt: Total wall length.
Fw: *IBS* Factor for wall system.
S: *IBS* Score for other simplified construction solutions, as build ability and repetition.

2.3. Calculation of IBS degree for patterns of structural and executive solutions used for buildings in Syria:

The *IBS* degree for patterns of structural and executive solutions used for buildings in Syria was calculated based on the projections and building's data, and using the equation 1. Note from the fig 2 the high points of the *IBS* for pre-cast concrete system in Syria (82% - 86%), and this shows the importance of this system and the large role in the technological and production development required in Syria. Where it offers many advantages in terms of the production of a large number of units and the reduction in cost and time and improves the quality of the work [10]. The composite system comes in second place, it has a limited use in the shelters housing (pre-cast concrete and metal) increased by 67.25%, this shows the important role of this system in limiting the effort at the site and reducing the time necessary to accomplish the task to a large extent. In third place, is the cast-in-place concrete system with tunnel templates by 64%. In fourth place was the composite system (pre-cast concrete and cast- in- place) with 61%. Followed by the cast-in-place concrete system in the case of a framework structure with 34%, and it is noted that this system existing in many of the Syrian buildings and must work to improve its points in the future. In last place came the cast-in-place concrete system in the case of reinforced walls with 13.1% and this low rate is due to the absence of the use of technology and the need for a lot of effort at the site. It is therefore concluded that the use of a high proportion of the components of *IBS* in order to obtain the building industry needs to move towards prefabrication and other advanced technologies. Units manufactured in Japan accounted for about 20% until the year 2000 [18]. While in Malaysia up to 10% of the total overall housing units [19]. The manufacturing use in Syria is low, due to the lack of local knowledge in many aspects, especially its application, and the prefabrication factories are rare, despite the fact that plans for reconstruction depend on rapid construction systems and turnkey construction.

2.4. Identification and analysis of factors affecting the construction industry in Syria:

There are many important factors affecting the construction industry, and due to the complexity of these factors, their importance must be identified and determine according to Syrian reality and meet the needs of reconstruction, so it was resorting to the questionnaire, which is good means for the collection of field data and is characterized by the possibility of collecting information from multiple sources of the study sample and analysing it to reach specific results.

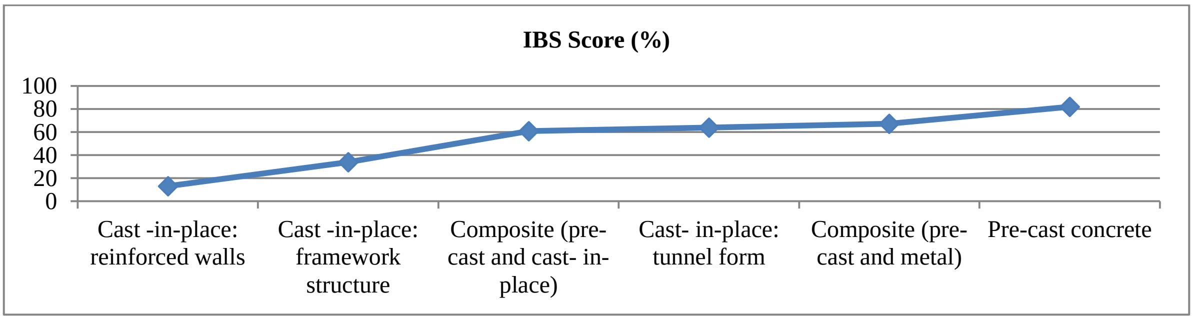

Figure 8: *IBS* Scores according to building system. Source: Authors' own calculation, 2015.

2.5. The design of questionnaire:

It has reviewed several previous international research studies, including [12], [20], [21], which looked at evaluating the performance of the construction industry, and found a number of important factors affecting this industry. The questionnaire was distributed to 100 establishments operating in the field of engineering; the experience of each individual in the sample is ten years in minimum and up to 40 years. The study sample ended with 51 acceptable responses which have been analyzed.

2.6. Statistical methods used in the study:

To test the availability of internal consistency and coherence between the answers, were calculated the Cronbach's alpha coefficient (Alpha- cronbach) as a reliability coefficient was calculated, where the result coherence coefficient for the current application part is 96.1%. And for the part of the future importance is 98.4%, knowing that the acceptable value of Cronbach's alpha coefficient is (60%), also we observed high truth values of both parts so can depend on the study sample answers and then data analysis, to analyze the data from the questionnaire, we used the SPSS 19 program. Analysis shows from the economic point a significant decline to adjust the construction time, and this indicates a clear deviation in controlling the duration of the projects. But from the human resource management point of view, we note a high repetition of answers in the low category for each of the variables security and safety of workers and training and education, which refers to the urgent need to achieve safety requirements in the projects and provide the necessary rehabilitation courses. In terms of infrastructure, we note the low application for availability of factories and support mechanisms for the construction industry, and provide a means of specialist technological transport, which leads us to work on the supply, and importing logistics and technology suitable to the reconstruction plan in Syria. We noted a reduction of all the environmental variables indicating the omission of the environmental aspect in the Syrian construction projects. According to the regulatory and streptococcus management side, note the heavy reliance on the lowest price in the bidding management, high government bureaucracy which constitutes a major obstacle for the success of the Syrian construction projects. Administratively, we noted the decline of the availability of managerial skills, as well as reduced government intervention through the enactment of laws and regulations, and the follow-up of existing projects, and this is what refers to the importance of developing the administrative enactment of laws adequate with the reconstruction plans.

2.7. Steps to implement the AHP:

For decision-making about the technology that must be followed using one of the decision-making tools, a method of hierarchical analysis of the *AHP*. The process of the *AHP* include three basic steps: the first step is to build a model of hierarchical analysis, which consists of the primary goal, alternatives and the main and sub-criteria, the second step is to demand from decision makers to individually express their opinions regarding the relative importance of the criteria and preferences between alternatives using paired comparisons, the third step is to prioritize the decision. After preparing the overall shape of the model, and introduction of the preference values to the program (expert choice) for comparison of the alternatives (technical systems) for standards, was obtained the result of the final paired comparisons of alternatives according to figure 3. Shown in figure 3 that technical system which received the highest importance, among other technical systems is the technology advanced prefabrication system and that had the winning percentage of 39.4%, and the researcher returned it to the extent of the actual importance of the advanced prefabrication technology, which stems not only from its large contribution in the rapid construction, but also in its ability to fill a large proportion of the housing needs of the Syrian citizen especially in light of the risks to the destruction of Syria and the pressures of development and the great need of reconstruction. The technical composite system (cast-in-place, pre-cast) came second with 21.8%; followed in third place by a low difference developed technology the cast-in-place system gaining 20.8%.

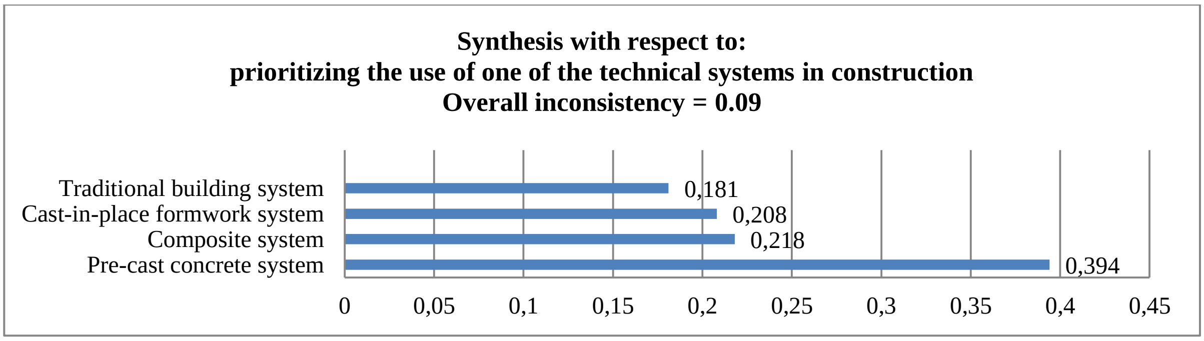

Figure 9: order of technical building systems after a paired comparisons using expert choice. Source: Authors' illustration, 2015.

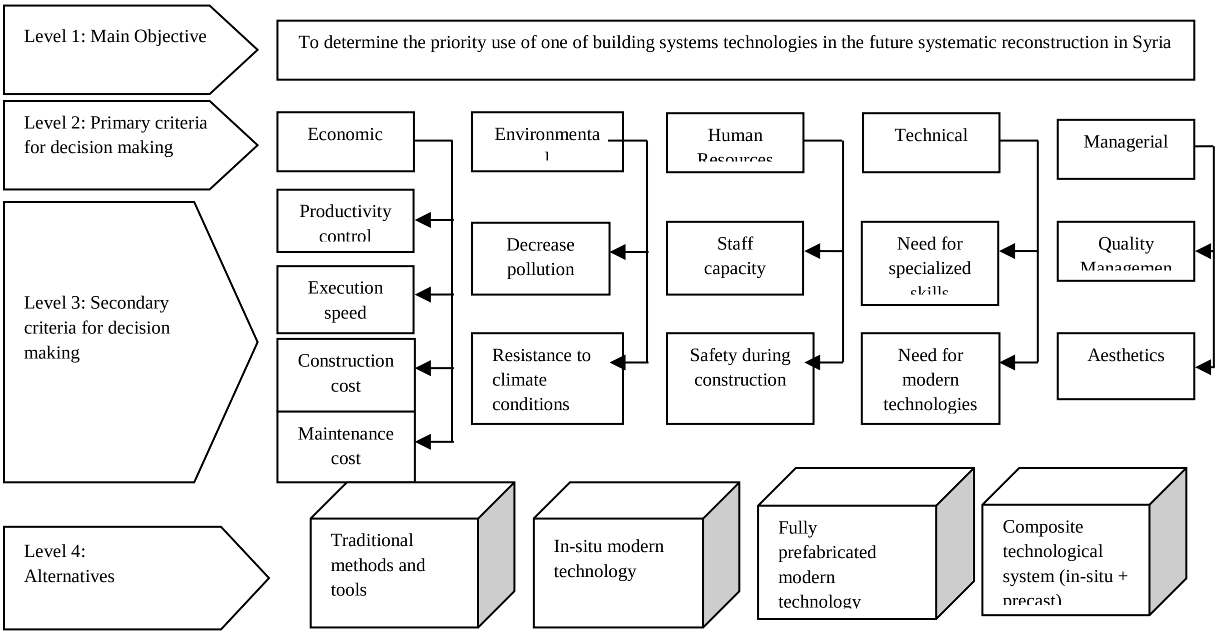

Figure 4: Hierarchical analysis to determine the priority alternative (Source: Authors' illustration, 2015).

3. Conclusions and Recommendations

This paper looked at the definition and classification of *IBS* and characterization of their own construction techniques, as this paper discussed the level of the construction industry in the Syrian construction projects, and discussed the evaluation of the factors affecting the construction industry through accurate and comprehensive field study.

Given the importance of existence a comprehensive methodology in Syria to adopt strategic issues for the Syrian construction industry, we have identified priorities for choosing the right technical system for building within the reconstruction system in Syria, and reached the following conclusions and recommendations:

- The use of the building industry systems *IBS* in Syria can offer the benefits of speed, quality and safety for construction projects, and achieve the construction requirements.
- Obtaining a high level in *IBS* requires a move towards industrialization.
- Through the assessment of the IBS value for patterns executive solutions used for buildings in Syria, a system of cast-in-place concrete in the case of reinforced walls had 13.1%, while for cast-in-place concrete in the case of the framework structure it was 34%, the composite system (pre-cast and cast-in- place) had 61%, tunneling templates had 64%, for the composite system (concrete and metal) it was 67.25%, and pre-cast concrete gained from 82% up to 86%.
- *IBS* is facing significant challenges in Syria, according to the survey results, which showed a significant reduction in the current application of most of the factors affecting the construction industry.
- Using the method of *AHP*, the advanced technology prefabricated system was on first place with 39.4%, followed by the composite technical system (cast-in- place + pre-cast) with 21.8%, in third place advanced cast-in-place technology with 20.8%, as stated in last rank were traditional methods and tools.

Acknowledgements

This work was supported by the Grant Agency of the Czech Technical University in Prague, grant No. SGS15/132/OHK1/2T/11.

References

[1] Beshara, M., Hassan, B. (2015). Construction Industry as a Requirement for Reconstruction Phase in Syria, 1st Engineering Conference on Reconstruction and Development Priorities. Latakia, Syria. In Arabic.

[2] M. Mohee, H. Bayati, Study of the Efficiency Performance of Precast Building: Practical Research on Civil Engineering Department of Building - University of Tikrit. J. Diyala of Engineering Sciences. (2011) 1-22. ISSN 1999 – 8716. In Arabic.

[3] W. Pan, A. G. F. Gibb, A. R. J. Dainty, Strategies for Integrating the Use of Offsite Production Technologies in House building. Journal of Construction Engineering and Management. (2007). 138 (11), pp. 1331 - 1340.

[4] K. A. Mohd Kamar, Z. Abd Hamid, M. N. A. Azman, M. S. S. Ahamad, Industrialised Building System (IBS): Revisiting the Issues on Definition, Classification and the Degree of Industrialisation. International Journal of Emerging Sciences. (2011) 1: 120-132.

[5] Thanoon, W.A., Kadir, M. R. A., Jaafar, M. S., & Salit, M. (2003). The essential characteristics of industrialised building system. International Conference on Industrialised Building System. KL. Malaysia.

[6] Idrus, A., Hui, N. F. K., & Utomo, C. (2008). Perception of Industrialized Building System (IBS) Within the Malaysian Market. International Conference on Construction and Building Technology, ICCBT. (07), 75- 92.

[7] H. Aburas, Off-Site Construction in Saudi Arabia: The Way Forward. J. Archit. Eng., 122-124. Doi: 10.1061/(ASCE)AE.1943-5568.0000048

[8] Abdullah, M. R., Mohd Kamar, K. A., Mohd Nawi, M. N., Haron, A. T., Arif, M.(2009). Industrialised Building System: A Definition and Concept. ARCOM Conference. Nottingham, United Kingdom.

[9] Jabar, L, I., Ismail, F., Mustafa, A., A. (2013). Issues in Managing Construction Phase of IBS Projects. Procedia - Social and Behavioral Sciences 101: 81-89. International Conference on Quality of Life, Malaysia. doi:10.1016/j.sbspro.2013.07.181

[10] Construction Industry Development Board (CIDB). Manual for IBS Content Scoring System (IBS SCORE). 2010, Kuala Lumpur, Malaysia.

[11] Rahman, A. B. A., Omar, W. (2006). Issues and challenges in the implementation of industrialised building systems in Malaysia. Proceedings of the 6th Asia-Pacific structural Engineering and Construction Conference, Kuala Lumpur, Malaysia.

[12] Abdul Kadir, M. R., Lee, W. P., Jaafar, M. S., Sapuan, S. M., Ali, A. A. A. (2006). Construction Performance Comparison Between Conventional and Industrialised Building Systems in Malaysia. Structural Survey, 24: 412-424.

[13] M. Arif, C. Egbu, Making a case for offsite construction in China, J. Engineering, Construction and Architectural Management, 17 (6) (2010), 536- 548. Doi.org/10.1108/09699981011090170

[14] Lessing, J., Stehn, L., Ekholm A. Industrialised Housing: Definition and Categorization of the Concept. IGLC-13 Sydney, Australia. 2005.

[15] Badir, Y. F., Kadir M. R. A, Ali A. A. A. Theory of Classification on Badir-Razali Building System Classification. Bulletin of Institute of Engineer. 1998.

[16] Baxi, C. K. (2011). Formwork – A Concrete Quality Tool. 36th Conference on Our World in Concrete & Structures. Singapore, 14-16.

[17] Mia, R. A Methodology for Evaluating Projects' Management and Performance Modeling to Improve the Quality of Projects Execution Strategies in Syria. 2008. Ph.D. thesis, Syria, Tishreen University. In Arabic.

[18] Nagahama, M. Japan's Prefabricated Housing Construction Industry - A Review. Global Agriculture Information Network (GAIN). 2000.

[19] Construction Industry Development Board (CIDB). Roadmap Review (Final Report). CIDB, Kuala Lumpur, Malaysia. 2007.

[20] YUNUS, R. Decision Making Guidelines for Sustainable Construction of Industrialised Building Systems. 2012. Ph.D. Thesis. Faculty of Built Environment and Engineering, School of Urban Development, Queensland University of Technology.

[21] Salahuddin, S. N. H. Factors Influence Construction Time Performance for IBS in Malaysia Construction Industry. Masters' thesis, Faculty of Civil Engineering, University Technology Malaysia. 2010.