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The Utilisation of Inustrialised Building System in Design Innovation in Construction Industry

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Abstract: Since the introduction of Industrialised Building Systems (IBS) in the construction industry of Malaysia, there have been doubts and speculations on the usage of this new system of building construction in the application of innovations in building design. This doubt has been proved from the findings of past researches. The aim of this paper is to investigate on the different opinions of stakeholders' involved in the design process of a building on the compatibility of IBS in design innovation and the factors that stem these opinions. With the use of quantitative method of data collection, a questionnaire was developed and pilot survey was carried out to test its validity. The main survey was carried out on a population of 120 respondents representing the clients, engineers, architects and construction managers from 72 IBS contractor firms and 34 property developers within the environs of Penang State. A total of 64 replies were analysed. The data were analyzed using descriptive statistics and Relative Importance Index (RII). The findings show that standardization, inadequate knowledge of the concept of modular coordination and insufficient research on IBS components and application of building components was identified as the key factors affecting the application of IBS to design innovation.

Key words: Design Innovation · Industrialised Building Systems · Stakeholders · Factors · Malaysia

INTRODUCTION

Evidently, the history of man is often influenced by the introduction of new technologies which has resulted to the satisfaction of the human social community. Every age has been marked by the evolution of new techniques for the creation of a comfortable shelter, yet never before the twentieth century has the evolution and application of new technologies been so accelerated and with such consistently broad dimensions [1].

For centuries, the construction industry reserves the uncompromised pride as the gateway provider and facilitator of global physical development through the provision of infrastructures, manpower development, resource employment, fixed capital formation and improvement of the gross domestic product. This has over the years, made the industry one of the most dynamic and challenging fields resulting to its undergone series of changes and improvements. Amongst the numerous improvements evolving in the industry is the emergence of the industrialised building system (IBS) which has produced massive enhancement in productivity and quality, in building construction. This is attained only through intensive industrialisation and building system process development which has immense inherent advantages in term of productivity, indoor quality, durability and cost [2].

Design is becoming increasingly important in determining the success of any project in the industry as clients are becoming knowledgeable in their expectations from the project team; increasing in nature and complexity [1]. Innovation in project design is a strategic means of achieving clients' needs better and even surpassing their expectations. Design has a strongly rooted connection between the meaning of plan and intention, as intention and plan both belong to the domain of design thinking [3]. As it is not the structure but the organization which drives the structure; design within this research covers the activities which take place within architecture and construction that correspond to transforming ideas and beliefs into a plan for implementation through thought, planning and analysis.

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Design Innovation: Design is a key concept within the construction and designing world mostly within architecture, interior design, industrial design, engineering design, graphic design, urban design, information system design, interaction design (software design) and fashion design [4]. It is often said that design is the process that links creativity and innovation [5]. Hence, designers have strived to make a satisfactory meaning to plan and intention with a strategically creative design for the provision of both physical and mental satisfaction. This has steamed their hunt for uniqueness through innovative strategies in the construction industry.

Slaughter [6] defines Innovation as the actual use of nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change. As such, technology has been an important factor in influencing design innovation by the introduction of new working methods, tools etc. and the constant development of new technologies continues to set new premises for building design, allowing them to explore new possibilities and create new aesthetics [7, 8]. The ongoing technological advancement and its increasing development pace makes it likely that this trend of development of new design approaches will continue and that new aesthetic forms will be created as a result of these new possibilities [7, 8].

Although technological development has existed throughout history, the 19th and the 20th century were marked by new technology which changed the society on a scale which had never previously been seen [9]. These considerable changes in 19th and the 20th century, as a result of technological development, were viewed as rational, progressive and unstoppable within broad sections of western society, including architects and people acting like industrial designers [9]. Many designers welcomed new technological developments, as it gave them a break from a previous climate of traditional design, which can be characterised as preferring safety and the relics from the past. Technological development was not only seen as a chance to create new styles, but it was seen as offering opportunities for introducing a new way of life [9]. Hence, designers are focused upon the possibilities and opportunities technology creates rather than determining the potential side effect and challenges [8]. Due to this factor, the everyday life of people was irrevocably changed and affected with the introduction of industrialisation which brought about mass-manufactured goods, mass-communication systems and mass-transportation.

IBS and Malaysian Construction Industry: In Malaysia, the use of IBS has increased with the encouragement from the government; resulting in the production of numerous housing projects in the past years. During the five years of the Ninth Malaysian Plan, Malaysia built an amazing one million dwelling, which constantly amazes visiting building professionals. The use of IBS has made Malaysian housing industry one that mass-produces more houses on per capital basis than any other countries in the world. Recently, The Government of Malaysia encouraged the use of IBS by mandating the use of IBS components especially in new government office building projects up to 70% in 2008 and finally to achieve full industrialization by 2010 [10].

The similarity between IBS and design is not farfetched as IBS can be seen as a product of design thinking and innovation and also a sincere move towards the provision of infrastructure and building facilities to the general public at large [11]. Local players in the construction industry have reiterated the need to adopt the IBS to help cushion the impact caused by escalating oil prices and building materials [12]. In the long run, IBS adoption will benefit the construction industry through faster delivery time, better productivity and reduce unskilled workers [12]. Under the IBS roadmap for the period 2003 to 2010, Construction Industry Development Board (CIDB) has spent a lot of time and money undertaking research and development (R&D) activities. As identified by authors, an industrialised building system allows flexibility in architectural design in order to minimise the monotony of repetitive facades [13] and also provides flexibility in the design of precast element as well as in construction so that different systems may produce their own unique prefabrication construction methods [14].

Problem Statement: Since the introduction of Industrialised Building System (IBS) and its promises to solve and improve the current construction method and scenario in the country, the perception amongst the construction stakeholders towards its applicability in design is an issue which greatly contributes to the low usage of IBS components in the construction industry and thus the term "IBS" is often been misinterpreted with negative conception due to poor design [15].

Amongst many reasons of the critical factors that have led to the un-acceptance of the notion that it does not support innovation in the design ability of designers. This issue of its applicability to innovative designs has been one of the prevailing barriers to its full adoption.

This is because architects still see IBS as alien and rigid to creativity and innovation. For instance, Hamid *et al*, [16] pointed out that the use of Industrialised Building System is always not popular among designers as they found that pre-fabrication has limited their creativity in design. The designers of a project which includes the architects and engineers have had the enormous responsibility of effectively marching their designs with the application of IBS in construction.

Trikha [17] maintains that the implementation of IBS is particularly hindered by lack of scientific information. Thus, there is need to choose between the designs that could be built with widely available systems in the market and producing specialised designs in offsite that will allow aesthetic attributes. This stiffness in flexibility of design has resulted to the fact that clients are often in doubt of using IBS because of fear of customer rejection.

Defects resulting from lack of technical expertise and poor quality control which cause aesthetic and functional faults, such as cracks, blemishes, moisture penetration and poor thermal insulation in completed buildings [13] are a major concern to the project contractor; and this stems from a defective design of building components which in turn results to a defective production of the building components. As a matter of fact, contractors perceive change in work and defective design as the most recurrent risk in IBS projects [18]. For instance, a contractor is faced with the problem of effecting the changes made in the design of a project by the designers after the design process, which was caused by the unstable client's requirement. This may result in defective production of the building elements as changes cannot be implemented without influencing the production schedule.

Hence, this study aims at investigating the different opinions of stakeholders' involved in the design process of a building on the compatibility of IBS in design innovation and the factors that stem these opinions.

MATERIALS AND METHODS

This research was conducted by means of questionnaire survey. The stratified sampling method was applied to this research locating respondents within the environs of Penang, Malaysia. There are 72 registered IBS contractor firms [19] and 32 property developers [20] in Penang State. As used by Idrus *et al*. [21] in his study on Perception of IBS within the Malaysian Market, a target of 120 respondents was set consisting of 30 architects, 30 construction managers, 30 engineers; and 30 property developers representing the clients which represents the stakeholders in the Malaysian construction industry in accordance with the research requirements. These questionnaires were distributed through mail post, hand delivery and email to respondents who are involved with the design of construction projects in the industry. In order to obtain a valid and consistent result of feedback, a minimum of 30% of replies was set for statistical analysis [22].

The structuring of the questionnaires addressed the objective of this research and was aided by a review of related literature on the research variables. The questionnaires were created with reference to the existing questionnaires available from previous researches [23, 21]. The questionnaire forms were designed to be simple requiring minimal filling-in time. Questions asked were to rate the factors that affect the use of IBS in design innovation identified through a pilot survey conducted with representative of the stakeholders involved in the design process of a building design as used by [24, 25]. The factors identified are thus:

- Inadequate knowledge of the concept of modular coordination.
- Standardization of building components.
- Insufficient research on IBS components and application.
- Poor understanding of the construction clients and their needs.
- Poor management in the construction firms.
- Lack of integration within the project team.
- Poor organization of work schedule.
- Lack of proper planning of projects.

The respondents were requested to rate a set of hypothesis made with the factors mentioned above according to a five-point Semantic Differential Scale [26]. Semantic differential scales measure a person's attitude toward concepts and provide reliable quantitative data. The Five (5) categories of skill rating which represents the feedback of the respondents to the hypothesis made in the questionnaire was used to show priority of Strongly disagree (1), Disagree (2), Moderately agree (3), Agree (4) and Strongly agree (5).

The data gathered through questionnaire were compiled and entered into the computer to be developed and analysed. As the quantitative method of data collection which provides numerical data, was used, it is necessary to analyse the data statistics using the descriptive analysis which details the frequency of response. The relative importance index (RII) was used to deduct the importance level of each tested variable as follows:

$$\text{Index Average} = (\Sigma ai \times xi) / \Sigma\, xi$$

Where: ai = constant, weighing factor; xi = variables representing respondents' frequency.

This method is used in the research by Idrus *et al*, [21] on Perception of IBS within the Malaysian Market and by Basri, [23] on critical success factors for IBS adoption in Malaysian construction Industry. Result from the findings is presented in the form of graphs, histograms and pie chart for easier understanding.

A total of 64 out of 120 respondents returned the questionnaires while a total of 51 questionnaires were completed and useable for analysis. This represents 43% of the respondents which is satisfactory as it is above the targeted minimum response of 30%. Thus the data is adequate for analysis.

Table1.1 depicts the job category of the respondents. Construction managers form the highest number of respondents of 19 respondents (37.3%), followed by architects 17 (33.3%), clients' response were 7 (13.7%), while engineers 4 (7.8%) and others, also 4 (7.8%) formed the minority population of this report.

Most of the respondents have a good experience in the industry. According to Table 1.2, 18 respondents between 7 to 10 years forming the highest year range of the respondents (35.3%), 15 (29.4%) respondents have an experience between 4 to 6 years and respondents with an experience of 10 years and above and; between 1 to 3 years have a number of 9 (17.6%) respondents each.

Thus, a total of 73.5% of the respondents that have been in the construction industry between the years ranges of 4 years and above. This is a good statistical result as respondents whose working experience is at least 4 years have had sufficient knowledge concerning conventional systems which has been practiced and they are able to compare the advantages and flaws of both systems. This proves that the data collected is reliable and good for the opinion based survey.

RESULTS AND DISCUSSION

There are many factors that affect the various opinions of stakeholders' in the application of IBS to innovative designs. These issues act as hindrances to the successful adoption and usage of IBS in the construction industry. In respect to building design and innovation in design, some factors were identified through literature review, pilot survey and discussion with supervisor.

Table 1.1: Job categories of respondents

	Job Category		
	Frequency	Percent	Cumulative Percent
Architect	17	33.3	33.3
Engineer	4	7.8	41.2
Construction manager	19	37.3	78.4
Client	7	13.7	92.2
Others	4	7.8	100.0
Total	51	100.0	

Table 1.2: Respondents experience

	Experience		
Experience	Frequency	Percent	Cumulative Percent
1-3 years	9	17.6	17.6
4-6 years	15	29.4	47.1
7-10 years	18	35.3	82.4
10 and above	9	17.6	100.0
Total	51	100.0	

Table 1.3: Opinion on IBS promotes innovation in building design

	Ibs Promotes Design Innovation		
	Frequency	Percent	Cumulative Percent
Strongly disagree	3	5.9	5.9
Disagree	1	2.0	7.8
Moderately agree	18	35.3	43.1
Agree	22	43.1	86.3
Strongly agree	7	13.7	100.0
Total	51	100.0	

IBS promotes Innovation: The literature review carried out on Industrialised Building Systems stated that the use of IBS promotes and encourages innovation in building designs. This view is supported by the responses of this study. A percentage of 53% architects, 25% engineers, 64% construction managers and 72% clients rated agree and strongly agree to this point. From Table 1.3, a total of 29 respondents are of the opinion that IBS is a product of building innovation, 18 respondent responded moderately agree on this point and only 4 respondents disputed this notion. Thus is can be deduced that the use of IBS promotes Innovation.

Factors Affecting Stakeholders' Opinion on IBS Usage in Design Innovation: Various factors were identified from literature review of published surveys and articles on IBS in Malaysia construction industry [16, 21, 23] etc. These factors were subjected to a pilot survey to determine the relevant factors critical to building design and IBS usage. After due consideration and pilot survey, eight (8) factors were selected and set as determining factors to IBS usage in building design. The respondents were asked to rate the selected factors in order to identify the key factors affecting stakeholders' opinion on the usage of IBS in building design. The responses of the respondents are tabulated according to each category in Table 1.4 and explained below:

Table 1.4: Opinions on key factors affecting stakeholders' opinion on IBS and design innovation

	Respondents category					
Factors affecting the use of IBS in design innovation	Architect (RII)	Engineer (RII)	Contractor (RII)	Client (RII)	Total (RII)	Rank (All)
Standardisation of building components	0.86	0.85	0.91	0.8	3.43	1
Inadequate knowledge of the concept of modular coordination	0.79	0.7	0.82	0.89	3.20	2
Insufficient Research on IBS components and application	0.8	0.8	0.76	0.83	3.19	3
Lack of proper planning of projects	0.79	0.8	0.74	0.8	3.13	4
Poor management in construction firms	0.79	0.65	0.81	0.8	3.05	5
Poor understanding of Clients' needs	0.71	0.85	0.76	0.69	3.01	6
Poor organization of work schedule	0.68	0.6	0.69	0.77	2.74	7
Lack of integration within project team	0.62	0.65	0.72	0.71	2.70	8

Architects: From the table, architects ranked Standardisation of building components (RII = 0.86) as the major issue to design innovation in IBS projects with insufficient research on IBS components and application as the 2nd (RII = 0.8). In their opinion, the level of research carried out on IBS is not adequate to venture the many avenues of exploiting the concept of IBS and its application to innovative building designs. This limits the ability of designers to produce innovative designs. Lack of integration within the project team was seen as the least issue to be considered with RII = 0.62. Thus, according to architects, the standardization of building components is the major issue to innovative design amongst IBS projects.

Engineers: All the engineers are of the opinion that Standardisation of building components and poor understanding of clients' needs (RII = 0.85) are the key issues affecting stakeholders' opinion on the use of IBS in building design. According to their rate of response, designers do not understanding explicitly the requirements and expectations of clients and as such, they find it difficult to incorporate the standards of IBS component application to meet the clients' needs while designing a building project. However, they also identified lack of proper planning of projects and insufficient research on IBS components and application (RII = 0.8) as likely issues to this problem. Thus, engineers are of the opinion that standardisation of building components and poor understanding of clients' needs; are the key issues affecting stakeholders' opinion n the use of IBS in building design.

Construction Managers: Construction managers also believe standardization of building components is the key factor affecting the compatibility of IBS with design innovation with RII = 0.91. In their opinion, this limits the ability of designers to be innovative in their designs when incorporating IBS into the design of buildings. Although they identified inadequate knowledge of the concept of modular coordination (RII = 0.82) and poor management in construction firms as pressing issues (RII = 0.81). The construction managers saw lack of integration amongst project team (RII = 0.72) and poor organization of work schedule (RII = 0.69) as the least factors.

Clients: Most of the clients who responded think that designers do not have adequate knowledge in the concept of modular coordination (RII = 0.89) as such; it poses as the major issue on the ability to design innovatively with the use of IBS. The clients also believe that insufficient research on IBS components and application (RII = 0.83) has added to this problem ranking it the 2nd key factor affecting the compatibility of IBS to building design amongst designers. Lack of integration with the project team (RII = 0.71) and poor understanding of clients' needs (0.69) were seen as the least factor to consider as the issues affecting stakeholders' opinion in the use of IBS for design innovation.

From the findings, it is evident that different stakeholders have different views on the factors affecting the compatibility of IBS to building design amongst designers. Whereas architects, engineers and contractors regard standardisation of building components as the key factor affecting IBS and design innovation, clients think the problem lies with inadequate knowledge of the concept of modular coordination. Engineers also think that poor understanding of construction clients and their needs contributes greatly to this problem.

However, some issues are prominent and recall in the analysis of opinions made by the stakeholders. As such, the key factors are identified based on their relative important index (RII) amongst the respondents. Generally, the key factors affecting stakeholders' opinion on the use of IBS in design innovation are summarized as thus:

Standardization of building components is ranked 1st as it carries the highest total relative importance index (RII) = 3.43 giving a gap of 0.17 points above the 2nd ranked factor which is the inadequate knowledge of the concept of modular coordination with a total RII of 3.20. This is closely followed by insufficient research on IBS components and application with a total RII of 3.19. Lack of proper planning of projects came in as the 4th factor affecting the compatibility of IBS in building design innovation with RII = 3.13. Then comes poor management of construction firms as the 5th with RII = 3.05, next to this are poor understanding of clients' needs as the 6th with RII = 3.01 and poor organization of work schedule as the 7th issue with RII = 2.74. Lack of integration within the project is regarded as the least issue that affects the application of innovation in IBS designs with RII = 2.70 amongst the group.

Three key factors are identified amongst the eight evaluated as the most effectual factors; these key factors are:

- Standardisation of building components (RII = 3.43)
- Inadequate knowledge of the concept of modular coordination (RII = 3.20).
- Insufficient research on IBS components and application (RII = 3.19).

Standardisation of Building Components: Standardization of building components in the use of IBS is essential for accomplishing the requirement of modular co-ordination for production. This entails the prescription of tolerances at different construction stages such as manufactured tolerances, setting out tolerances and erection tolerances, so that the combined tolerance obtained on statistical considerations is within the permitted limits [17]. This is done at the design stage of a project when specifications are detailed for construction.

Standardisation as observed by Verweij & Voorbij [27] would benefit IBS in term of reduce costs by simplification of business process between organisations, increase in efficiency on how organizations carry out their work, simplifies communication, reduced time to align business processes and systems and improved utilisation of human resources. This argument is supported by Pan *et al* [28] in his survey to the house builders in UK about IBS implementation. ISO 9000 and ISO 1400 are well known international recognise standard to deal with quality management and environmental management respectively.

However, designers struggle with these standardization and will rather stick to the easy and common designs with well known specifications which they can play around with while designing a building. This view is supported particularly by the respondent contractors (0.91) and architects (0.86) since the RII were considerably high compared to other factors.

In the specific perspective, Gibb (2001) cited in Basri [6] had observed that the most important area for standardization is actually the interfaces between the components rather than the components themselves. Failure to deal with the complexity of interfaces at an early stage with these issues will neglect some of the potential benefits to be gained in using IBS [29]. Therefore issues such as tolerance at interfaces between different systems faced by the contractors have to be closely coordinated. Such interfaces might include the joints between differing modular or panel systems, interfaces between new and existing construction, details of pipe work and electrical connections between factory made products and site-installed mains.

Inadequate Knowledge of the Concept of Modular Coordination: The respondent architects and clients believe that designers do not acquire adequate knowledge of the concept of modular coordination. The academic curriculum in the universities seldom incorporate courses that technology, organization, construction and the design of IBS [13]. As such, designers who have acquired the necessary education and training in design cannot understand this alien technology and cannot incorporate it in their design. This makes it difficult to promote the use of IBS into the construction industry and poses a great hindrance to its usage and compatibility with design innovation. If the designers cannot incorporate modular coordination concept of IBS, how then can they be innovative and creative with the IBS concept to produce innovative building designs?

In the course of this study, a respondent architect stated that it is good to use IBS but it needs a lot of modification in the traditional design method by local architects. And it there is need for the architect to know how the machine work first. It's like Lego architecture. If we have 1000 component, we can make 100,000 variable of design. This further emphasizes the need for designers to have a good knowledge of the concept that stems industrialisation of building systems-modular coordination. Like Lego architecture whose concept is the modelling of designs in a micro-scale thus creating the ability to produce more variables of designs, if designers have the basic knowledge of modular co-ordination, they can become flexible and easily produce different creative and innovative designs in the traditional and most viable local context.

There is need to educate our designers in IBS concept of modular coordination and this can not be restricted to just the practicing designers but should be extending to the universities and institutes of technology. Developing a training program for IBS is a meticulous and complex task. The important aspect of emulating good training program is to correctly identify skills gaps in the whole construction process of completing a construction work.

Insufficient Research on IBS Components and Application: Considerable research efforts have been directed toward the "hardware elements" of the industrialized building systems technology. However, the hardware elements are only concerned with the structure itself. Nonetheless, to date, the "software elements" of the industrialized building systems, which are concerned with the data and information available on the system, users, clients, establishment of manufacturing and assembly layout and process, as well as allocation or resources and material, have received little attention. This has affected the ability of designers to incorporate these "software elements" of IBS in the building design. There is therefore a dire need to overcome the shortage in the software elements of the building system research [30].

Research can be carried out to study the constructability of architectural designs usually drafted by architects and designers and the viability of such designs in the modern environment. Also Technology can be furthered to improve the suitability of the machine design to the local industry so that the usage of IBS in the industry will meet local social conditions, materials, climate giving top priority to the building tradition (Dragsholt, 1984 cited in [23]. This lessens dependency on foreign technology. The design of structural concrete frames for IBS has come under scrutiny as architects; design engineers and contractor strive to find optimum economy, speed of erection and highest specifications for the project (Elliot, 2003 cited in [23].

DISCUSSION

Another constraint pointed out by a respondent engineer is that of cost which affects the incorporation of IBS in the design process. This issue of cost has been the major constraint of the construction industry resulting in the use of cheap and unskilled labour which limits the use of IBS designs and advancement in innovation. With the introduction of National Economic Model (NEM) which is a transformation of the National Economic Policy (NEP), it is hoped that the industry can afford the use of skilled labour and IBS expertise thus encouraging the incorporation of IBS designs in construction.

As observed by the National Economic Advisory Council (NEAC), Malaysia is losing its skilled talent which it needs to drive future growth as many are leaving to seek better opportunities elsewhere quoting an estimate by the Ministry of Human Resources, that in 2008 some 350,000 Malaysians were working abroad, over half of whom had tertiary education [31]. The NEM for Malaysia Part 1 Report released on 30th march 2010 is aimed at transforming Malaysia from a middle income to an advance nation by 2012 by focusing on the human dimension of development. As such, this respondent sees IBS implementation in the industry as one of the major avenues to achieve this as this will attract skilled labour and encourage the practice of indigenous IBS expertise.

Designers who apply the concept of IBS in building designs should be more creative and innovative by exploring different ways of IBS usage in design. They should equip themselves with the knowledge of modular coordination so that they can effectively manage the intricacies of IBS designs and resolve the issue of standardization of building components as it is shown that this is the key factor affecting designers in applying the concept of IBS in building designs. This can be achieved by an extensive sensitisation and teaching of the rudiments of standardisation so as to clear the mist and confusion in its application. Also, the concept of IBS should be incorporated in the syllabus of our universities and institutes, practitioners should be sensitized further on IBS components and applications and the government should encourage extensive use of IBS in the local context. There is need for the government to include the design in its policies governing the use of IBS to encourage innovation.

The implication of this study is that whereas stakeholders appreciate the introduction of IBS in the construction industry, they are not so eager to involve IBS in the design of projects l*et al*one indulge in innovation in IBS designs due to issues relating to the concept of IBS application in building design.

The limitation of this study is that the sample population for this research might not be a representation of the options of stakeholders in other parts of the country as such it might not be used to generalise results for the whole of Malaysia. Research can be carried out on IBS design in the other states of the country in order to obtain a more generalisable result on stakeholders' opinion on IBS and design innovation in the construction industry in Malaysia.

Further research should be conducted on building design and application of the concept of IBS components in order to ensure the flexibility and compatibility of IBS concepts in building design especially in the local context with the use of indigenous materials.

CONCLUSION

The aim of this study is to investigate on the different opinions of stakeholders' involved in the design process of a building on the compatibility of IBS in design innovation and the factors that stem these opinions. Three (3) key factors affecting the application of innovative designs in the use of IBS were identified namely: standardization of building components which was the most important factors; inadequate knowledge of the concept of modular coordination and insufficient research on IBS components and application. It was also deducted from this study that stakeholders in the industry are of the opinion that the use of IBS promotes innovation in building design.

The implication of this study is that whereas stakeholders appreciate the introduction of IBS in the construction industry, they are not so eager to involve IBS in the design of projects let alone indulge in innovation in IBS designs due to issues relating to the concept of IBS application in building design.

Further research should be conducted on building design and application of the concept of IBS components in order to ensure the flexibility and compatibility of IBS concepts in building design especially in the local context with the use of indigenous materials.

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