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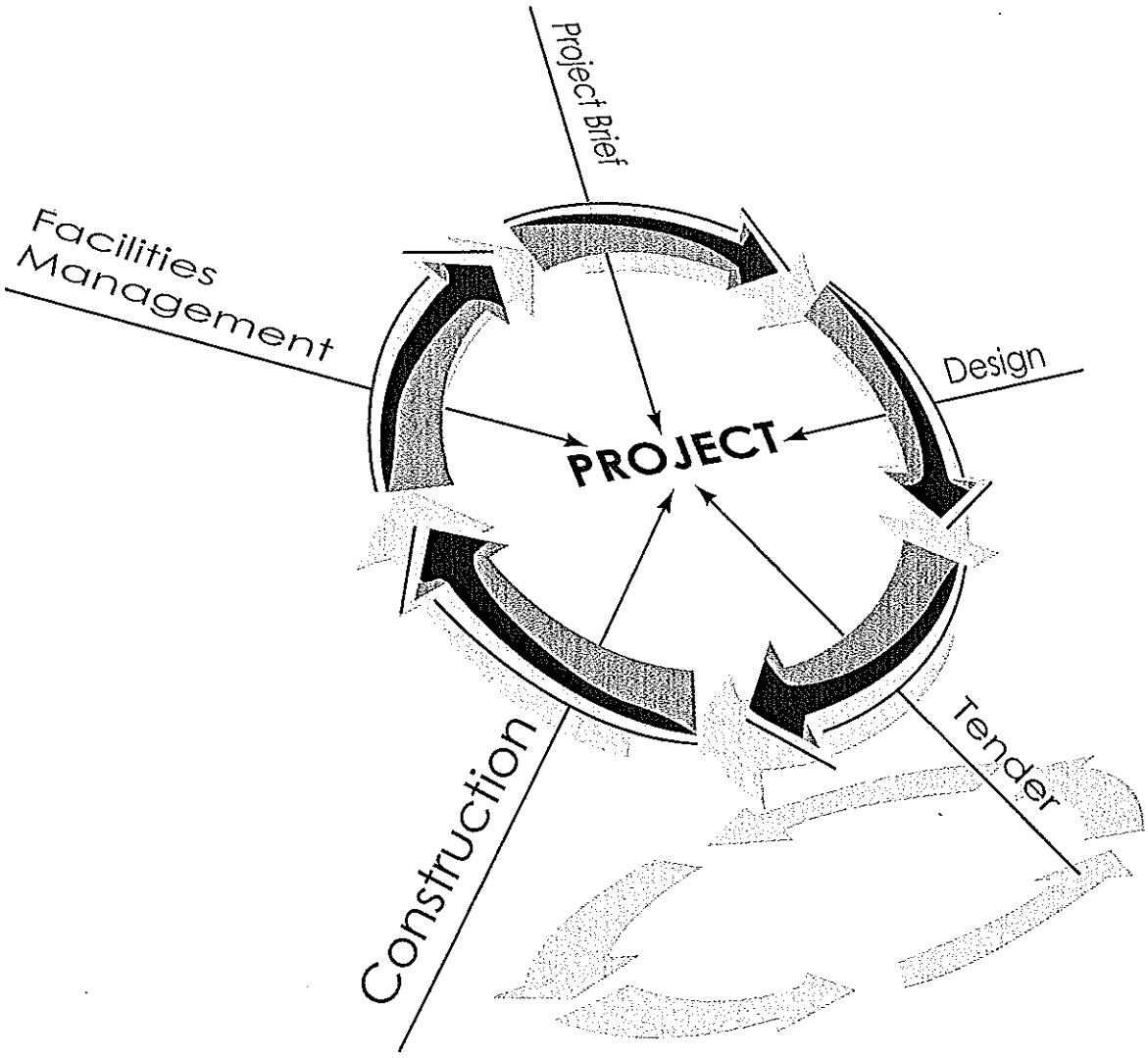

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CONSTRUCTION QUALITY OF SCHOOL BUILDINGS USING THE INDUSTRIALISED BUILDING SYSTEM (IBS)

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Abstract
One of the major problems in the Malaysian construction industry is the shortage of skilled labour. Due to this shortage, many contractors have resorted to employing semi-skilled and unskilled labourers thus resulting in poor workmanship in construction. To overcome this and its related problems, the Malaysian Government through the Construction Industry Development Board (CIDB) presently encouraged the IBS method of construction by the industry. With this initiative in place, it is expected that the quality of construction in buildings will be further improved. The aim of this study is to assess the quality of selected school buildings in Malaysia constructed using the Industrialised Building System (IBS) method of construction and comparing it with the quality of buildings constructed using conventional construction methods. This study involves the physical inspection of buildings, an analysis of the defect lists obtained from the relevant authorities and a questionnaire survey circulated to end users to obtain a feedback on their perception on the quality of the completed buildings. The results of this study demonstrate that the quality of IBS-constructed buildings had substantially better quality as compared to those constructed by the conventional methods. The result of the study together with numerous other studies on the IBS construction method would encourage the Malaysian construction players to increase the use of IBS in future construction projects.

Keywords: *Quality, Industrialised Building System, Conventional Construction Method, School Buildings*

INTRODUCTION

One of the major problem faced by the Malaysian construction industry is the shortage of labour; precisely skilled labour (Megat Rus Kamarani *et.al.*, 2002, Thanoon *et al*, 2003a, Abdul Kadir *et.al.*, 2006, Hamid *et.al.*, 2008, Memon *et.al.*, 2011). Presently, most of the labourers used within the construction industry in Malaysia are foreigners and their influx into the country has caused many social-related problems which the Government has to grapple with (Abdul Aziz, 2001, Abdul Hamid *et. al.* 2011a). Due to this shortage, many contractors have resorted to employing semi-skilled and unskilled labourers in construction projects and this has resulted in poor workmanship and quality of the completed works (Abdul Kadir *et.al.*, 2005, Abdul Hamid *et. al.* 2011b, Hassan and Ismail, 2008).

The Industrialised Building System (IBS) in construction was first introduced in Malaysia around 1964 with the construction of a pilot project consist of 7 blocks of 17 stories housing flats at Jalan Perkeliling, Kuala Lumpur. (Thanoon *et.al.*, 2003a). Despite the fact that the system has been employed for over fifty years, surprisingly it has not been very well accepted by the Malaysian construction players (Hassim, *et.al.*, 2009).The Malaysian Government through the Construction Industry Development Board (CIDB) has been promoting the IBS construction method through "The Construction Industry Industrialised Board IBS Roadmap 2003-2010". This is a systematic and coordinated blueprint aimed at achieving a higher standard of quality coupled

with the adoption of new construction methods such as the Industrialised Building System (IBS) to push the construction industry to a higher level of quality and standards at par with that found in other advanced countries (CIDB, 2007). In 2011, a new IBS roadmap covering the period 2011-2015 was introduced and implemented to replace a previous one (CIDB, 2011). A key element in the latest roadmap is the focus given in emphasising private sector adoption of the IBS method of construction. To achieve the desired results, the CIDB has narrowed down its policy objectives to four main areas; which cover issues on quality, efficiency, competency and sustainability. The deployment of a sustainable IBS method of construction will hopefully contribute to the competitiveness of the construction industry in Malaysia.

The IBS method of construction is defined as a construction system where components are manufactured at factories on/or off site, transported and then assembled into a structure with minimum work (CIDB, 2011). The IBS can further be sub-categorised as the Frame System, Panelled System, Cast in-situ Formwork System, Hybrid System and the Modular System. Studies done on construction works in other advanced countries noted that this method of construction has generally improved the quality of buildings and has substantially reduced the number of workers required to execute the work (Lessing, 2005, Lau, 2007, Oostra & Joonson, 2007, Goodier and Gibb, 2007, Pan *et.al.*, 2008).

Arditi and Gunayande, (1997) defined quality as meeting the legal, aesthetic and functional requirements of a project. In the construction industry, quality can be defined as meeting the requirements of the designer, contractor and regulatory bodies as well as the client. Workmanship is not the only factor in determining the quality of the finished products in construction. The use of space functions in a way that add to the quality of life for those who use them are also important elements to be considered in the pursuit of better quality in construction. Other factors such as the quality of design and space planning (Gann et. al, 2003a), economy of construction, operation and maintenance (Leaman and Bordass, 2001), safety and security and accessibility to the handicapped are additional elements that need to be considered in ensuring higher quality buildings that must be considered. The durability of the materials specified and used in the building construction is also important to produce quality buildings that have longer longevity with less maintenance cost (Majid *et.al.*, 2010).

Whilst the construction industry has been dealing with the conventional method of building construction for a good many years, this method has inherent weaknesses such as too many on-site activities which are both time consuming and labor intensive (Mohd Nawi *et.al.*, 2009). The introduction of the IBS method of construction should bring about improvement and much needed betterment of the construction industry. However since its introduction in Malaysia in the 1960s, the impact of IBS on the development of the construction industry and quality of the finished work as a whole left much to be desired (Abd Rahman & Omar, 2006, Kamar*at.el.*,2007).Many studies have been carried out on the IBS construction method in Malaysia such as awareness, usefulness, ease of use and hindrances to its implementation (Majid *et. al.*, 2010,Thanoon *et.al.*, 2003a, Thanoon 2003b, Kamar *et.al.*, 2009), however further studies are needed to evaluated the level of improvement that IBS as a construction method has contributed, namely in three important elements of construction i.e. time or duration, cost and quality (Hamid *et. al.*, 2008).

The focus of this study is on the quality of building construction using the IBS method of construction. The aim is to assess the quality of selected school buildings constructed using the IBS method by comparing with those built using conventional construction method. School buildings are selected as representative of building types as these are average in size and complexity. The aim of this paper is to present an objective comparison through specific methods in order to quantify the qualitative impact of the IBS construction method by using buildings of similar complexity.

METHODOLOGY

From the literature reviews conducted, the quality of buildings can be measured in 3 distinct phases throughout the building life cycles (Arditi and Gunaydin, 1997); namely the pre- construction stage i.e. during design and planning (Gann *et.al.,* 2003b, Abdul Rahman, 1996, Tan and Lu, 1995), during construction and upon certificate of practical completion (CIS7, 2006) and post occupancy (Bordass, 2001) where customers' satisfaction are measured (Kärnä,2004). Comparative studies between IBS (prefabrication) and conventional method of construction had been carried out by a few researchers (Abdul Kadir *et.al.,*2006, Chen *et.al,* 2010) to measure construction performance such as productivity, structural cost, crew size, cycle time, constructability and quality. However the data were collected through questionnaire surveys, thus representing a "measure of quality in perception" (Arditi and Gunaydin, 1997).In this study, an attempt is made to measure "quality in fact" of a building through the eyes of experience professionals by carrying out systematic inspection of a building instead of relying on a questionnaire survey which measures the perception of the respondents. It also attempt to utilise secondary data (the defects list) by the relevant authorities. Questionnaire surveys were also carried out to measure the end users perception on quality of the buildings being studied.

Location of Study Site

The schools that were selected in this study were based on the following criteria:

i. Building completed about the same time thus the "age" of the selected buildings is rather similar.
ii. The buildings are located in the same region i.e. Lembah Klang.
iii. The buildings were about similar size in terms of construction build-up.

These criteria are chosen so that an objective comparison can be made between the schools built using the IBS method of construction and those constructed using conventional methods.

The schools were chosen based on the list of completed and on-going school projects given by the desk officer in-charge of schools projects in the Public Works Department (PWD) headquarters. The Public Works Department is a government technical department which is responsible for the implementation of government projects including schools in which they act as the project management consultants. Although the usage of the IBS method of construction for schools has been implemented since 2008, only a few schools have since been built using this method. The projects that use the IBS method of construction are mainly additional blocks to existing schools. Consequently the earliest completed IBS method of construction for schools available as samples in the study location have only been delivered to the clients in less than a year and have been occupied in less than 6 months.

After a thorough study on the availability of the relevant samples, only two schools constructed using the IBS method and one school constructed using the conventional method of construction fulfilled the above criteria. However the built up area of the school using the conventional construction method is 1.5 times bigger than the selected IBS-constructed schools.

Data collection

Data were collected by several methods and are listed as follows:

A. Physical and visual inspection and assessment on the quality of the completed building. Check list was based on the Construction Industry Standard 7 (CIS7) document by CIDB (CIDB, 2006)

B. Quality perception surveys i.e. post-occupancy surveys targeted at end-users of the buildings

C. Defect lists (prepared by the project appointed consultants) obtained from the District Public Works Department who supervised the projects.

The IBS construction system used in the schools studied is a precast concrete frame system with standardised components (doors & windows) where the beams, columns, slabs and staircases are cast in the factory and the contractor installed the members on-site after completion of the foundation works. The walls were built using a conventional method i.e. brickworks finished with cement mortar plastering and later painting work.

Physical and Visual Inspection

CIDB has introduced a system where the workmanship quality of a building can be assessed by using the CIS7 method of evaluation. For this study, the inspection checklist was adopted from the Quality Checklist for Architectural Works and defect rating column was added to the checklist. Since the study was carried out after the buildings had been completed, the Quality Checklist for Structural Works was not used as this requires the inspection for structural works to be carried out during the construction period. However structural elements that are visible such as beams, columns, slabs and staircases were inspected. Since the school buildings did not use any air conditioning systems, a quality checklist for Mechanical and Electrical works was not carried out. The inspections were carried out on the new buildings, a floor-by-floor starting from ground floor till the top most floors. The defects and quality of the finishes on the building elements such as floor, beam, internal wall, ceiling, doors and windows, roof, gutter and rainwater down pipe, external wall, perimeter drain and apron, corridor and staircase were noted and a defect rating was given to these elements.

The defect rating given for building elements are shown in Table 1.

Table 1. Defect Ratings

Defect Rating	Terms	Explanation
1	Satisfactory	Elements contain almost no defect
2	Minor	Elements have some defects but defects are minor and not many
3	Medium	Elements have some defects but defects are not major and not many
4	Major	Elements have many defects and the defects are major
5	Severe	Elements have many defects and the defect are severe and need to be repaired soon

The inspection was led by the researcher who has more than 20 years of experience in building construction and was assisted by two building technicians who had more than 10 years' experience each which included inspection of buildings before the issuance of the Certificate of Practical Completion (CPC) in building projects. Experienced inspectors are important because they are able to assign more accurate defect ratings to the buildings. To ensure consistent ratings are given to the level of defect found in the buildings, the same technicians were employed throughout the study. Equipment such as electronic measuring device, spirit level, L shaped ruler and steel rod are used to check the verticality, level, height, length width and the solidness of the concrete structures. Photographs of the defects were taken and marked in the checklist.

Quality Perception Survey

A quality perception survey was carried out by the teachers who used the buildings understudied. The sampling was done based on a non-probability basis where the population does not have an equal chance of being selected. 22 of the questionnaires relate to buildings constructed using the conventional method whilst 19 relates to buildings using the IBS method of construction.

The questionnaires were prepared based on the literature review conducted and to meet the objectives of the study. It was divided into three sections namely demographic of the respondents, perception on the quality of the buildings and ranking of factors that determine the quality of a building. The quality factors investigated were aesthetic, detailing and finishing, functionality of building, comfort, defect, durability and safety and security. From the literature review conducted, in order to achieve quality in buildings would require an interactive approach to the design process over and above just aesthetics, detailing and finishing (Gobster and Chnoweth, 1989, Susilawati *et. al.*, 203, Vilnai-Yavetz *et. al.*, 2005, Rustom and Amer, 2006). A pilot survey was carried out to verify the relevance of the intended questionnaires in capturing the factors or aspects contributing to the research objectives and to ensure that the questionnaires were adequately understood and not misleading. The questionnaire was subsequently refined accordingly. The survey questionnaires were printed in both English and Bahasa Melayu.

Pilot Survey

The draft questionnaire was distributed to a few students and lecturers; a combination of those with and without knowledge and experience in construction. The feedback collected was carefully considered and later used to amend, refine and improve the questionnaire. The most common comments were that the questions on aesthetic, function and safety aspects of the building need to be simplified for better understanding of the end-users who are mostly without the technical and construction background.

Defect Lists

At the completion of a project and before the issuance of the Certificate of Practical Completion, a final inspection was carried out by the PWD as the project manager, contractor, consultants and client. The outcome of this inspection included all the defects in the newly completed building as listed by the consultants for the contractor to repair before the project was handed over to the client. In this study the defects lists of the building understudied were obtained from the District PWD that was responsible for the supervision of the projects.

DATA ANALYSIS

From the physical and visual inspection, a defect rating for each element was summarized for the whole building. The highest rating that represents the worst in quality for each element was then taken and summarised. This is to reflect the worst condition for the elements in the whole building. The same process was carried out for buildings under studied constructed using both the IBS and conventional method of construction.

For the quality perception survey, a 5-point Likert scale method was used to indicate the level of agreement to the statement about quality in buildings. The ratings for the level of agreement by the respondents are as follows:

1 = Very low degree of agreement
2 = low degree of agreement
3 = Neutral
4 = High degree of agreement
5 = Very high degree of agreement

The data were analysed using the Relative Indices (RI) technique adopted by Holt *et al.* (1995)

$$RI = \frac{\sum (5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1)}{5(n_5 + n_4 + n_3 + n_{2+} n_1)}$$

where RI is the relative index

and n_5, n_4, n_3, n_2, n_1 are the number of responding indices

The computation of the RI using this formula yields values ranging from 0.2 to 1. The RI range and what it represents are shown in Table 2.

Table2. Categories for Range of Relative Index

Categories	RI Range
Very low level of agreement	0.20 – 0.35
Low level of agreement	0.36 – 0.51
Neutral in agreement	0.52 – 0.67
High level in agreement	0.68 – 0.83
Very high level in agreement	0.84 – 1.00

The respondents were also asked to list quality factors in the order of importance and the data were described using descriptive statistic.

In addition, the number of defects from the defect list was manually counted. It was expected that the number of defects to be larger when dealing with bigger size of building. Since the size of the buildings in this study was not the same, the number of defects was divided by the total built up floor areas of building under studied respectively. This was to allow for a more objective comparison to be made between the buildings regardless of its size.

Finally qualitative and quantitative comparisons were made between the physical and visual inspection, quality perception survey and defect list for the buildings constructed using both the IBS and the conventional method of construction.

RESULTS AND DISCUSSION

Result of physical and visual inspection and assessment

Table 3 is the comparison of summaries of the Quality Checklist for Architectural Works for the schools understudied. From Table 3 it was found that the defect ratings for the school constructed using the conventional method of construction are predominately 4 which is classified as severe, while the buildings constructed using the IBS method of construction showed a rating of mostly 1s or 2s which falls under the classification of satisfactory and minor. This statement is almost true for every building element in the buildings understudied which indicated that the IBS-built schools have a better quality than schools constructed conventionally. This is further verified when analysing the defect photos taken during the buildings inspection. Some of the photographs are shown in Figures 1 to 4.

Table 3. The Comparison of Summaries of the Quality Checklist

BUILDING ELEMENT	Inspection Standard	Defect Rating	Defect Rating	Defect Rating
		IBS School A	IBS School B	Conventional School C
FLOOR	Finishing	2	2	4
	Alignment&Evenness	2	2	4
	Crack andDamage	3	2	4
	Hollowness/ Delamination	3	1	4
	Jointing	2	2	4
	Tiled floor	1	1	3
INTERNAL WALL	Finishing	1	2	3
	Cracks and Damage	1	1	4
	Hollowness/ Delamination	1	1	4
	Alignment&Evenness	1	1	4
	Tilled Finishes	1	1	4
	Painting	1	1	4
CEILING	Finishing	1	1	4
	Crack and damages	2	1	3
WINDOW	Joint and gap	1	2	4
	Material and damages	1	1	4
	Functionality	1	2	3
DOOR	Joint and gap	3	1	5
	Material and damages	1	1	4
	Functionality	1	1	3
ROOF	Pitched roof	1	1	4
GUTTER & RAIN WATER DOWNPIPES	Visible damage	1	1	3
EXTERNAL WALL	Finishing	1	1	4
	Crack and damage	2	2	4
	Roughness	2	1	4
	Painting	2	1	4
PERIMETER DRAINS & APRONS	Drain	2	2	3
	Apron	2	1	4
STAIRCASE	Tread & Riser	1	1	4

Notes: *Defect Rating : 1 - Satisfactory 2 - Minor, 3 - Medium, 4 - Severe , 5 -Very Severe*

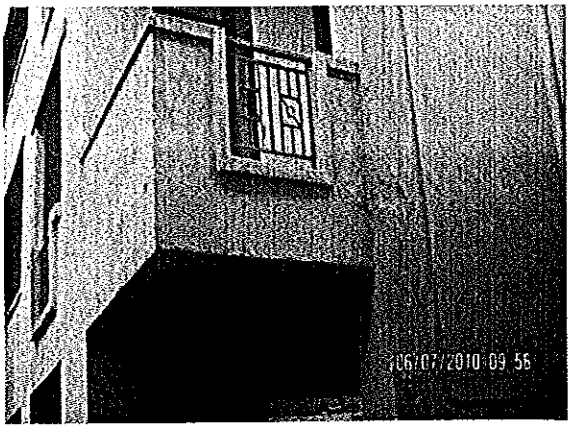

Figure 1. Poor plastering finishes of wall and column (Conventional Method)

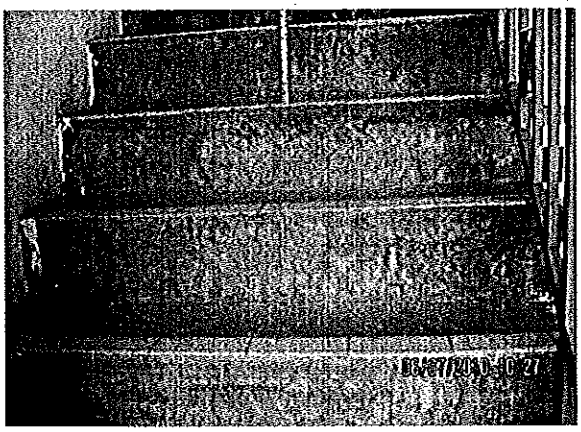

Figure 2. Inconsistent height of staircase riser (Conventional Method)

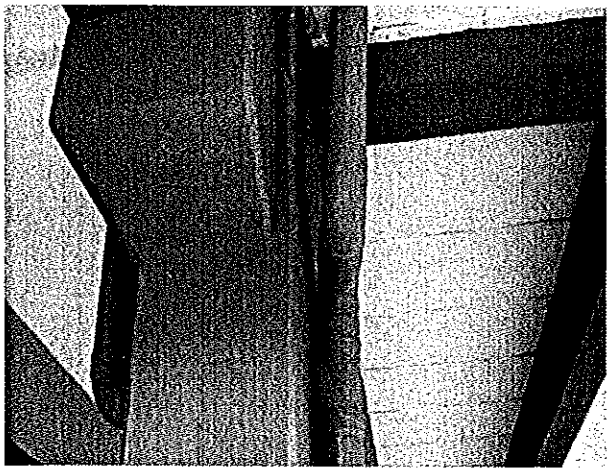

Figure 3. RWDP punch through pre-cast column and slab (IBS Method)

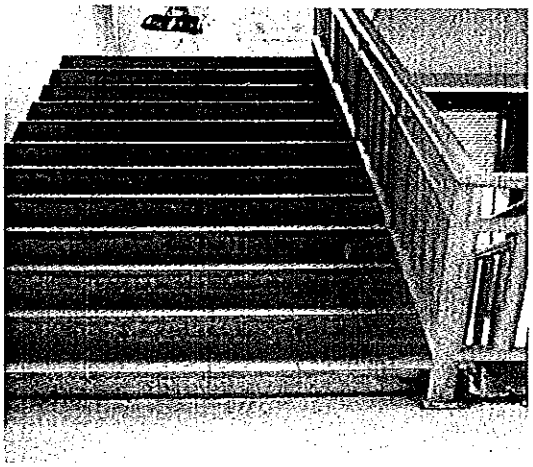

Figure 4. Consistent height of staircase riser (IBS Method)

Results of the Quality Perception Survey

Most respondents in this questionnaire surveys were teachers teaching in the buildings under studied. Their ages ranging between 35 to 43 years with an average working experience of more than ten years and an average of eight year tenure at their respective schools. These periods were considered as reasonable and adequate for them to give accurate and effective answers to the questions posed as they also have the experience of teaching in the old blocks in their respective schools. This is an important consideration so that they can feel the difference in the building quality between the old and the new blocks in their respective schools. In addition, between of 30% to 50% of the respondents are degree holders indicative of a high level of education amongst the respondents.

Table 4 shows the respondents' relative index to the questions posed about factors that contribute to quality in buildings. The results show that the respondents from school that were constructed using the IBS method of construction do not agree or disagree (neutral level of agreement) to all the questions regarding factors that contribute to the quality of a building except for defects in buildings. The relative index for all the factors that contribute to quality are 0.67 for aesthetic and functionality, 0.64 for comfort, 0.60 for durability, 0.58 for detailing and finishing and 0.56 for safety and security. The respondents, however, have a low level of agreement (0.44) on the defect factor which literally indicated to them that the buildings built by the IBS method of construction have fewer defects. For buildings constructed using the conventional construction method, comfort (0.71) and functionality of the buildings (0.68) have a relative index that indicated a high level in agreement. The rest of the factors that contributed to the quality of a building such as aesthetic, detailing and finishing, durability, safety and security and defect, the respondents registered a natural level of agreement. It is interesting to note that whilst respondents from schools constructed using the IBS method of construction were in a natural state of agreement pertaining to the five main factors that contributed to quality namely aesthetic, detailing and finishing, durability, safety and security; the RI recorded was a little higher as compared to values obtained from respondents addressing quality in buildings constructed conventionally.

Table 4. Respondents' Satisfactory Average Relative Index

Quality Factors	Relative Index (IBS respondents)	Quality Factors	Relative Index (Conventional respondents)
Aesthetic	0.67	Comfort	0.71
Functionality of building	0.67	Functionality of building	0.68
Comfort	0.64	Aesthetic	0.66
Durability	0.60	Durability	0.55
Detailing and finishing	0.58	Defect	0.55
Safety and security	0.56	Safety and security	0.55
Defect	0.44	Detailing and finishing	0.53

Ranking of Factors that Contributed to Quality

Apart from asking the respondents of their perception on quality of the under studied buildings which they use, question B8 asked them to rank from 1to 8, all eight factors that contributed to quality; with 1 being the most important and 8 the least important. Table 5shows the results for respondents from schools constructed using the IBS method and Table 6 are for schools constructed using the conventional methods. From Table 5 it was found that 71% of respondents from IBS-constructed schools had ranked safety and security as the top most factor, comfort (27%) second, functionality (35%) third, detailing (27%) fourth and fifth, functionality and innovation (20%) sixth, innovation (40%) seventh and 67% of the respondent has ranked aesthetic as the least important at number eight.

Table 5. Quality Factors Order of Importance to the Respondents (IBS method school)

Order of importance	1st	2nd	3rd	4th	5th	6th	7th	8th
Aesthetic (%)	0	0	12	7	7	7	13	67
Functionality (%)	0	13	35	20	7	20	0	0
Durability (%)	18	20	18	20	7	7	7	0
Innovation (%)	0	7	0	7	20	20	40	7
Detailing (%)	0	0	6	27	27	20	20	0
Comfort (%)	6	27	24	13	20	7	0	0
Form (%)	6	13	6	7	13	20	20	13
Safety/security (%)	71	20	0	0	0	0	0	13

Table 6 illustrated that the respondents from school constructed by the conventional method also ranked safety and security (82%) as the most important and aesthetic as the least important (72%). They had ranked durability in buildings (60%) second, comfort (71%) third, functionality (69%) fourth, form (44%) fifth, innovation and form (36%) sixth and detailing (57%) seventh.

Table 6. Quality Factors Order of Importance to the Respondents (Conventional method school)

Order of importance	1st	2nd	3rd	4th	5th	6th	7th	8th
Aesthetic (%)	0	0	0	0	0	21	0	72
Functionality (%)	0	7	0	69	25	0	0	0
Durability (%)	12	60	29	0	0	0	0	0
Innovation (%)	6	0	0	0	6	36	43	11
Detailing (%)	0	0	0	25	19	7	57	0
Comfort (%)	0	13	71	6	6	0	0	0
Form (%)	0	7	0	0	44	36	0	17
Safety/security (%)	82	13	0	0	0	0	0	0

It is interesting to note that the majority of the respondents regardless whether they are users of schools constructed using the IBS or conventional method of construction, are of the opinion that safety and security is the most important factor while aesthetic is perceived as the least important factor. Hence it can be concluded that the important factors to be considered in the design of buildings depend on the types of building and its intended usage. For schools, safety and security of the staff and students are paramount for the end-users as indicated from this study.

Defect lists

Table 7 shows the number of defects per 100 square meters of the respective schools. It was found that school buildings constructed using the conventional method of construction (School C) had the highest number of defects/100m² (6.2) as compared to buildings constructed using the IBS method (3.1 and 0.3). In fact the defect intensity of school buildings built using the IBS method are found to be less than half that for the conventionally built schools. In the case of School B (IBS method of construction), the defect intensity is lower than that for school buildings constructed using the conventional method by a factor of 20. Between the IBS-built schools, there was a big difference in defects between School A and School B. The unstructured interview with the supervisor of the projects revelled that that contactor for School B was a better contractor compared to that for School A and this was reflected in the less number of defects registered. Result from Table 7 clearly revealed the superiority of the IBS constructed schools over the conventionally built schools in terms of their defect intensity and quality. The data also verified and concurred with the findings obtained from the site inspection whereby the school buildings using the IBS construction method again proved that they were of much better quality compared to the conventionally built school buildings.

Table 7. No. of Defects per 100 Meter Square of Built up Area

Item	IBS method School A	IBS method School B	Conventional method School C
No of Defects	56	6	199
Built up area (m²)	1791.1	2133.8	3205.8
No of Defects/100m²	3.1	0.3	6.2

Physical and Visual Comparisons

From the physical and visual inspection and assessment it was found that the school buildings constructed using the IBS method showed a rating of mostly 1s or 2s which falls under the classification of satisfactory and minor while those constructed using the conventional method of construction are predominately 4 which is classified as severe. From the quality perception survey for most factors that contributed to quality, the IBS built buildings respondent's answers were in the neutral state of agreement (neither agree nor disagree) but when asked about the defects, they have a low level of agreement (0.44) which meant that the buildings built by the IBS construction method had less defects. From the defect lists, it is found that the defect intensity of the school buildings using the IBS construction method was less than half that of the conventionally built schools. From these comparisons it can be concluded that the school buildings using the IBS construction method displayed higher and better quality than those constructed conventionally.

CONCLUSIONS

To assess the quality of buildings constructed using the IBS method of construction, a comparative study was carried between school buildings constructed using this method and that constructed using the conventional methods of construction. Methods of assessment were done by physical and visual inspection and assessment, quality perception surveys by the occupants and comparison of the defects lists obtained from the authorities managing the projects.

Findings from visual inspection and assessment showed that school buildings constructed using the IBS method has a higher and better quality as displayed by the ratings adopted. The school buildings constructed using the IBS method showed a rating of mostly 1s or 2s which falls under the classification of satisfactory and minor while those constructed using the conventional method of construction are predominately 4 which is classified as severe.

From the quality perception surveys, respondents from school buildings constructed using the IBS method had a low level of agreement (0.44) when asked about defects indicative that school buildings built by the IBS method have less defects compared with schools constructed conventionally. Both groups of respondents from schools constructed using the IBS and conventional method are of the opinion that safety and security are most important whilst aesthetic was perceived as the least important factor.

From the defects lists, it was found that the defects intensity (number of defects/100m^2) of school buildings built by the IBS method of construction was less than half that of the conventionally built schools.

As a summary, it can be concluded that school buildings constructed using the IBS construction method showed far more superiority in quality when compared to those constructed using the conventional method of construction. This was also in line with the opinion of the teachers as end-users and technical personnel who were involved with the construction of the buildings. Besides the positive results in terms of higher quality obtained from the IBS method of construction, this method offers a faster rate of construction for building contractors. This is in agreement with the findings of other studies on construction in developed countries.

Limitation of Study

In this study due to the factors mentioned in location of study site, only 3 schools were studied and out of those three only one was conventional. Thus generalisation of the results just based on one case is less accurate. The quality of buildings varied due to the variation in the workmanship. The studies were performed on buildings constructed by different contractors who were employing different specialist sub-contractors and hence produced inconsistent standard of workmanship.

Recommendation for Further Research

In this study only a small element of quality was considered. For future research it is highly recommended that a bigger scope to cover all aspects of quality involved in the process of producing quality IBS building need to be strongly considered. The process shall include among others the planning and design, manufacturing of IBS components, transportation, installation, testing and commissioning and other related factors.

Selection of samples is very important. As more and more buildings are using IBS, selection of suitable samples and number of samples could be improved. Sample is the source of data and information which must be of highest accuracy in order to produce good and accurate results for the analysis.

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