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Purpose of the Series

The aim of this publication is to provide an opportunity for students to publish the findings of their undergraduate or postgraduate work. Guidance on publication will be given by staff who will act as second authors. It is hoped that by providing a guided transition into the production of papers that students will be encouraged throughout their future careers to publish further papers. Guest papers are welcomed in any field relating to the Built Environment. Please contact E.A.Laycock@shu.ac.uk. A template will be provided on request.

Acknowledgements

The editorial team would like to acknowledge and thank Will Hughes, Reader in Construction Management and Economics, University of Reading for permission to use the ARCOM template and the associated resources.

Editorial

As Editor of this publication it has been a great pleasure to work with staff and students from Tunku Abdul Rahman College (TARC) in the production of this themed Special International Edition. I would like to take this opportunity to present the forward to this edition made by Dr. Chua Ping Yong, the Head of the School of Technology at TARC.

Dr Chua Ping Yong obtained his first degree through the Diploma in Technology (Electronic Engineering) programme conducted in Tunku Abdul Rahman College. He later obtained his Masters Degree and PhD in Robotics from the University of Salford, United Kingdom. He has more than 20 years of lecturing experience and has been involved in control engineering and Robotics research since 2002. Dr Chua is currently the Head of the School of Technology in Tunku Abdul Rahman College. The School conducts programmes in Engineering (Electronics, Mechanical & Materials) and Built Environment (Architecture, Building, Quantity Surveying & Property Management) In his tenure as the Head of School, all the programmes conducted in the School of Technology obtained accreditation from the Malaysian Qualification Agency. The School currently conducts one of the most successful professionally accredited programme in Quantity surveying (fully accredited by the Board of Quantity surveyors Malaysia) and has close to a total of 1500 students on its Building and Quantity Surveying programmes. Many of the building graduates from the school are currently industry captains in the building industry in Malaysia and graduates from the School is still in high demand in the building industry in the region.

Dr Elizabeth Laycock

Editor, Built Environment Research Transactions

Dr Chua Ping Yong

Head of the School of Technology, Tunku Abdul Rahman College, Malaysia

Forward

It is with great pleasure for me to write the forward to this international edition which is created jointly by SHU and TARC. This is indeed a great pathway for TARC's students' works to be published and shared in an international forum. TARC is most grateful to SHU and especially to Prof. Paul Watson and his team for creating this opportunity for our students and graduates. This will indeed enhance the relationship that TARC has with SHU especially between the School of Technology and faculty of development and society. This will definitely inspire the final year students to greater efforts and ambition in the development of their final year project work. It has also now become a platform where TARC built environment staff can embark in research activities as this will be one of the pillars for the setting up of the Centre for Built Environment at TARC.

The areas covered in particular consideration of the conservation of historic buildings, the deterioration of timber by termite attack, the assessment of sick building syndrome and the uses of e-tendering in the Malaysian construction industry are areas that are of great interest in the Malaysian Built Environment context. I hope that this first step (again thanks to SHU) will provide the impetus for the publication of many more student works which will be a great bench mark for future student works. It is also with great pleasure for me to see the presentation of a review of the development of the relationship between TARC and SHU as I believe when we first began it was then unique and to last more than a decade (13 years to be exact) and still going strong is indeed a great achievement and a great model to be documented.

I would also like to thank all contributing authors and co-authors who have worked tirelessly in the writing of these papers and the editorial team for their important and essential work.

Dr Chua Ping Yong

Head

School of Technology

Tunku Abdul Rahman College, Malaysia

CONTENTS

REFURBISHMENT OF HISTORIC BUILDINGS IN MALAYSIA: A CASE STUDY ON HOTEL MAJESTIC KUALA LUMPUR

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ABSTRACT

The best way of preserving buildings is to keep them in use – a practice which the French call 'mise en valuer', i.e. modernisation with or without adaptive alteration. Adaptive use of historic buildings is often the only way these buildings can be brought up to contemporary standards while preserving both historic and aesthetic values in an economically viable manner. Lack of awareness in conserving heritage buildings in Malaysia has warranted immediate attention for a proper conservation framework to protect these buildings from the threats of further deterioration. The paper is aimed at raising awareness and increase knowledge in the context of heritage building conservation in Malaysia. To this regard, the paper will provide an in-depth insight on the refurbishment of plastering works of Hotel Majestic Kuala Lumpur. Historical Architectural Building Survey (HABS) was employed for documentation purposes of the hotel condition, of which the refurbishment works were classified as Class III conservation. With proper documentation of refurbishment works of the hotel, it would serve as a leading framework for conservatory works for similar refurbishment projects in the country. This would enable custodians of heritage buildings in Malaysia and the general population to better grasp the concept of heritage building conservation in Malaysia and thereby appreciate the importance of conserving these highly valuable assets of the country by continuously protecting them from further decay.

Keywords: Historic building, conservation, refurbishment

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INTRODUCTION

It is undeniable that British colonisation has shaped much of Malaysia today, from its plantation system to modern political institutions and architectural styles. Despite the profound British influence on the country which is still evident in these aspects, it disheartens many historic custodians that the legislation of the country is not as advanced as that of the United Kingdom when it comes to preserving historic buildings. Although there are studies indicating the growing awareness of the need to refurbish historic buildings, the amount of refurbishment works carried out in Malaysia are ironically not in proportion to the rate of deterioration of these buildings due to lack of constant maintenance. The current trend suggests that the lack of awareness has contributed to the lack of maintenance of the historic buildings, therefore accelerating the deterioration of these buildings of much sentimental values amidst the rapid evolution of the new development in the cities. The paper seeks to promote awareness among the layman in recognising the significance of conservation of historical buildings, which bear much historical value to the country and its people through process of identifying the conservation approaches used in preserving the façade of Hotel Majestic.

Despite the enactment of National Heritage Act in 2005 and the establishment of the National Heritage Department Malaysia in 2006, many heritage buildings in Malaysia remain in a miserable state, where they are subject to building decay which eventually, threatens their survival and ability to represent the Malaysian's own rich legacy of heritage values. It disheartens the heritage lover to see that the legislation in the country does not address the issues of conservation of historic buildings sufficiently, which leads ultimately to deterioration of the buildings under poor effectuation of heritage building management. Almost half of the heritage buildings which had been surveyed were in poor condition due to the lack of a maintenance framework for these buildings (Figure 1).

Within the 40% of the poorly maintained heritage buildings, a rough estimate of 80% of these buildings showed significant signs of deterioration, which was distressing news that depicted of the ineffectiveness of the country's legislation and regulations on conservation of heritage buildings (Figure 2).

Despite the signs of severe defects and deterioration found in the heritage buildings, survey carried out by Kamarul *et al.* (2008), as cited in Arazi Idrus *et al*. (2010), showed that there were little remedial works carried out to protect these buildings from further deterioration, let alone prolong their lifespan (Figure 3).

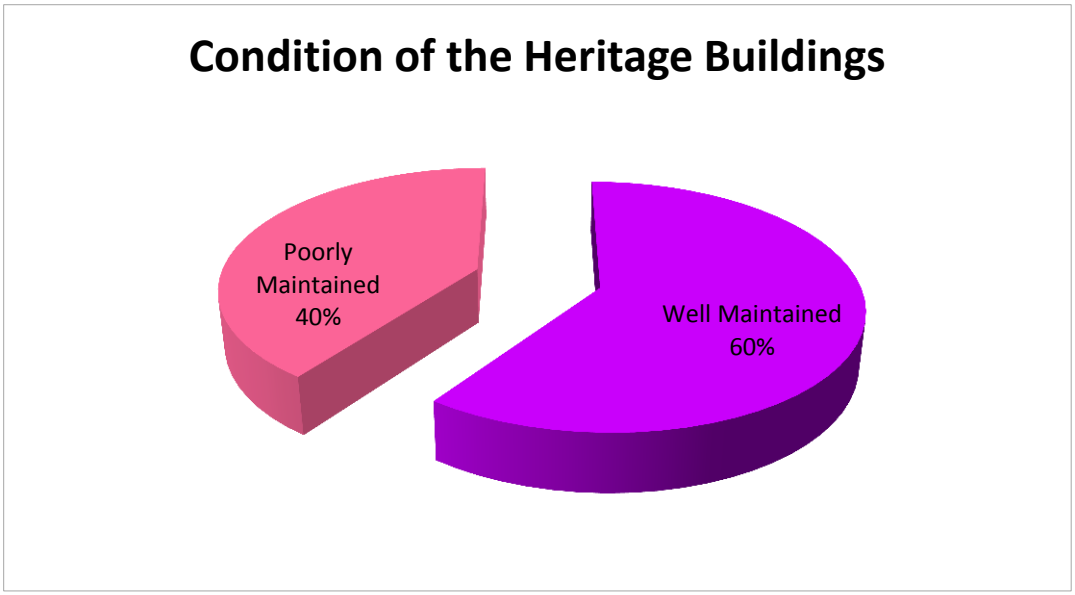

Figure 1: Condition of Heritage Buildings Surveyed
(Kamarul et al., 2008, cited in Arazi Idrus et al., 2010, p.69)

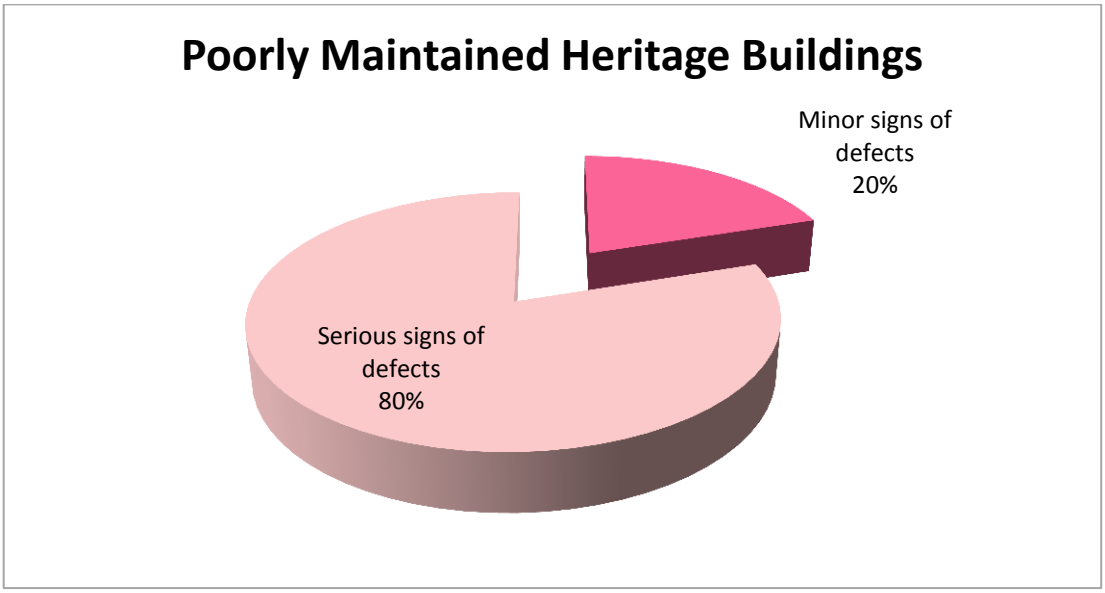

Figure 2: Condition of Poorly Maintained Heritage Buildings
(Kamarul et al., 2008, cited in Arazi Idrus et al., 2010, p.69)

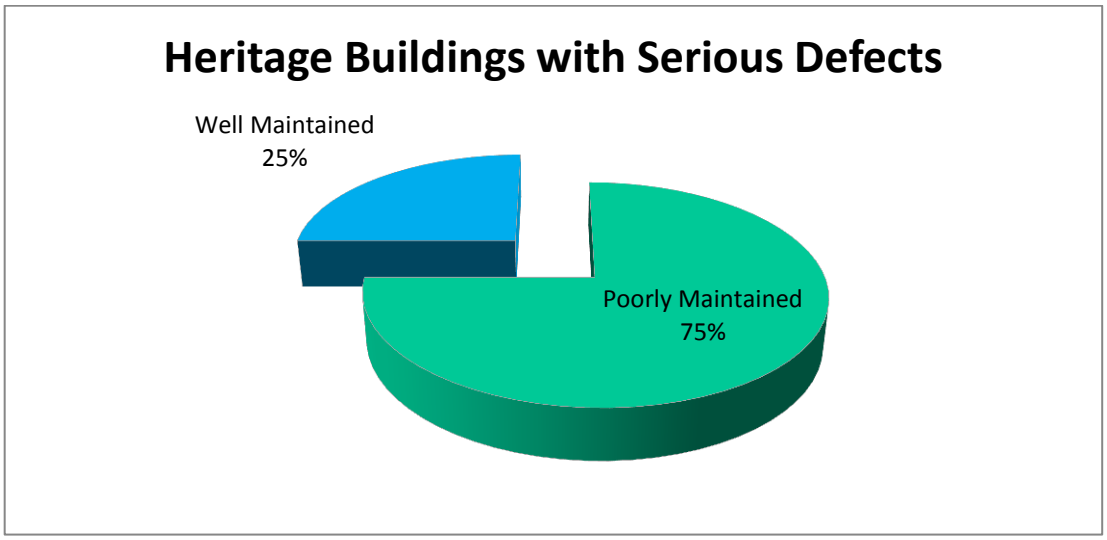

Figure 3: Condition of Heritage Buildings with Serious Signs of Defects (Kamarul et al., 2008, cited in Arazi Idrus et al., 2010, p.69)

LITERATURE REVIEW

Background Study of Hotel Majestic Kuala Lumpur

The discourse of the study revolves around the case study of refurbishment of Hotel Majestic Kuala Lumpur (Figure 4), which had been in derelict state for many years before it was proposed by the YTL Hotels and Properties Sdn. Bhd. to be reinstated to its prime once again, if not better than its former glory back in 1930's. Hotel Majestic Kuala Lumpur is located just next to the Railway Administration Building (Keretapi Tanah Melayu Berhad), off Jalan Sultan Hishamuddin, Kuala Lumpur, Malaysia (Figure 5). In the book titled 'Architectural Heritage Kuala Lumpur – Pre-Merdeka', PAM (2007) explicitly stated that the architecture firm which designed Hotel Majestic was Keyes & Dowdeswell. It was the exact Shanghai-based architecture firm that designed the far-famed Fullerton Hotel in Singapore, which was formerly a General Post Office building. Hotel Majestic was modern at the time of construction, year 1932, yet it was adorned with Neo-Renaissance and Art Deco detailing.

Figure 4: The former and abandoned Majestic Hotel (Wikipedia, 2007)

Once home to the former National Art Gallery, Hotel Majestic was an iconic landmark built in 1932, an era of British colonisation of Malaya. One may argue that the age of the subject discussed is only 79 years old, therefore a substandard heritage building as it does not fit the usual age criterion of 100 years or older for a heritage building. However, Parrott and Dellenbarger (1990) argued that despite the importance of age as the criteria for classification of historical structures, one has to be rational in justifying the age accordingly to its relative terms. The fact that Hotel Majestic Kuala Lumpur prevailed through the Japanese occupation during World War II and acted as the battle ground for independence of the country are good solid reasons for it to be called one of the country's heritage buildings despite falling short of age. One could not deny these historic buildings have high historical values which contain the nature our forefathers bore, that of perseverance in surviving the hardships come what may.

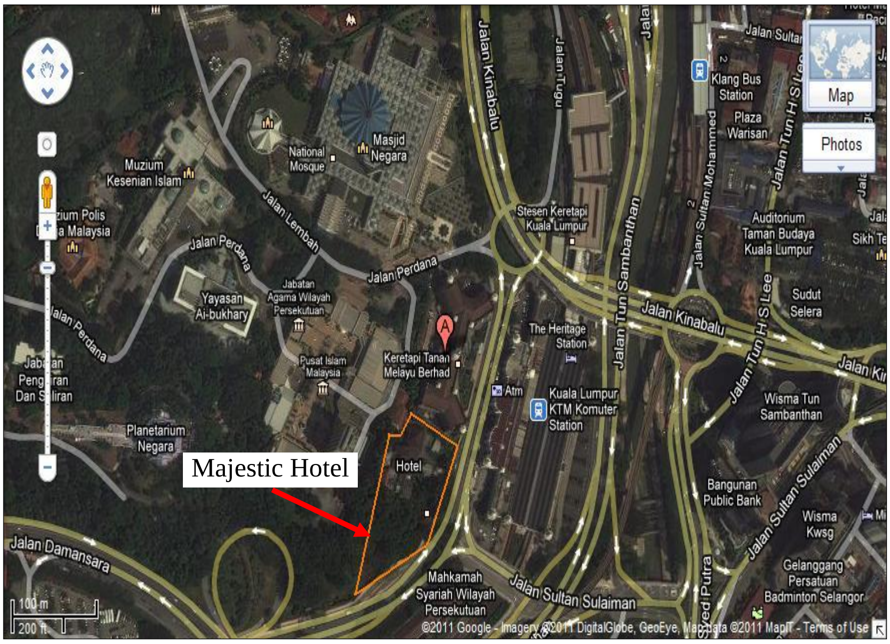

Figure 5: A map showing the location of the former Majestic Hotel (Wikimapia, nd)

Figure 6: Construction Signboard for Hotel Majestic Refurbishment Project (Source: Author)

From the construction signboard (Figure 6), it can be seen that the whole project of refurbishment works and extension work package for the hotel started on 12 Oct 2009. However, from the information gathered via informal interview during a site visit, the refurbishment work package only started mid-2011. Similar to the conservation works of the first classic hotel under the corporation, The Majestic Malacca, the company collaborated again with GSD Architect for its second magnificent hotel in its making.

Though not seen from the construction signboard, conservators from the National Heritage Department, commonly referred as *Jabatan Warisan Negara* by Malaysians, were engaged to ensure compliance of the conservatory works of Hotel Majestic with the regulations of the country.

AUTHENTICITY IN HOTEL MAJESTIC CONSERVATION WORKS

Site engineers encountered during site visit revealed that the refurbishment project of Hotel Majestic Kuala Lumpur falls into Class III conservation work. Since it was a Class III conservation work, the refurbishment works were limited only to the maintenance and repair of the building façade to its original in terms of building materials. All the original 51 rooms of the Hotel Majestic were being retained, of which only the wall finishes, be it externally or internally, were being kept to its original. By comparing Figure 7 and Figure 8, it can be observed that the building façade of the hotel was not being altered in any manner. From Figure 8, the façade was being barricaded properly with safety netting used.

How then does one determine the authenticity of a heritage building that has been left in a dilapidated and deplorable state for about two decades? Harun (2011) stressed that it is vital for one to know of the historical events which have occurred in and to the historic buildings. The rationale for such knowledge is to avoid the confusion of faux history blended with the old yet original history. On top of that, one has to be careful to explore into the architectural sense of the period when the building was erected for a better grasp of the building materials applied in that era.

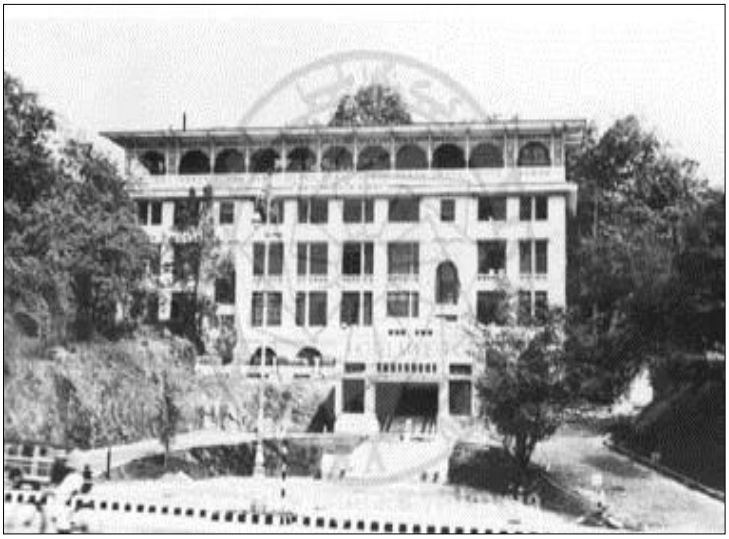

Figure 7: Hotel Majestic Kuala Lumpur in its prime (National Archives, 2005)

Figure 8: Hotel Majestic Kuala Lumpur during refurbishment works (Source: Author)

RESEARCH METHODOLOGY

The research instruments which were utilised in the quest of completing the paper are as follows:

- Primary Data Source
  A site survey was performed in order to gather insightful details on the process of refurbishment of Hotel Majestic Kuala Lumpur. With the consent letter from TAR College, the site visit was conducted upon the approval from YTL Hotels and Properties. Detailed processes from pre-refurbishment and during refurbishment of the wall finishes of Hotel Majestic were recorded with labelled illustrations.

- Secondary Data Source

Journals, articles, research papers, publications from corporate bodies and non-government institutions, newspapers, books and magazines were used for secondary data. These reviews were used as an appurtenance to complement the historical background and the architectural sense of the hotel.

FINDINGS

As conservators from the National Heritage Department were being engaged to assist in the conservation works of Hotel Majestic Kuala Lumpur, Historical Architectural Building Survey (HABS) was employed as the proper means of documentation of the condition of Hotel Majestic. HABS was introduced by the Museum and Antiquity Department of Malaysia in an effort to enhance the manner of documentation of the conditions of heritage buildings (Lee and Lim, 2010). It is a form of systematic compilation of documentary evidence which recorded the building conditions prior to, during and after conservatory works of Hotel Majestic.

Many photographs were taken during the reconnaissance survey to capture the existing state of the hotel, which were later used for tagging of the building defects accordingly to the grid location allocated. Further investigations were carried out during the dilapidation survey, whereby samples of old plaster of 300mm × 600mm were sent to the laboratory at the University of Science, Malaysia (USM) to identify the ratio of plaster components previously applied. Meanwhile, timber samples from within the hotel, which could be sourced from deteriorated timber door and window frame, were sent to the Forest Research Institute Malaysia (FRIM) to reveal the grade and types of the timber. A *Protimeter*, otherwise dubbed as ‘moisture meter’ in layman’s term, was used with the objective to test the moisture content of structures in the hotel itself.

Having obtained all the laboratory test results, these crucial data were then documented using the HABS protocol, which was accomplished by the engaged conservators who have the technical knowledge and experience in built heritage conservation works.

CONSERVATION PRACTICE

The conservation practice adopted in Hotel Majestic refurbishment project is shown in Figure 9.

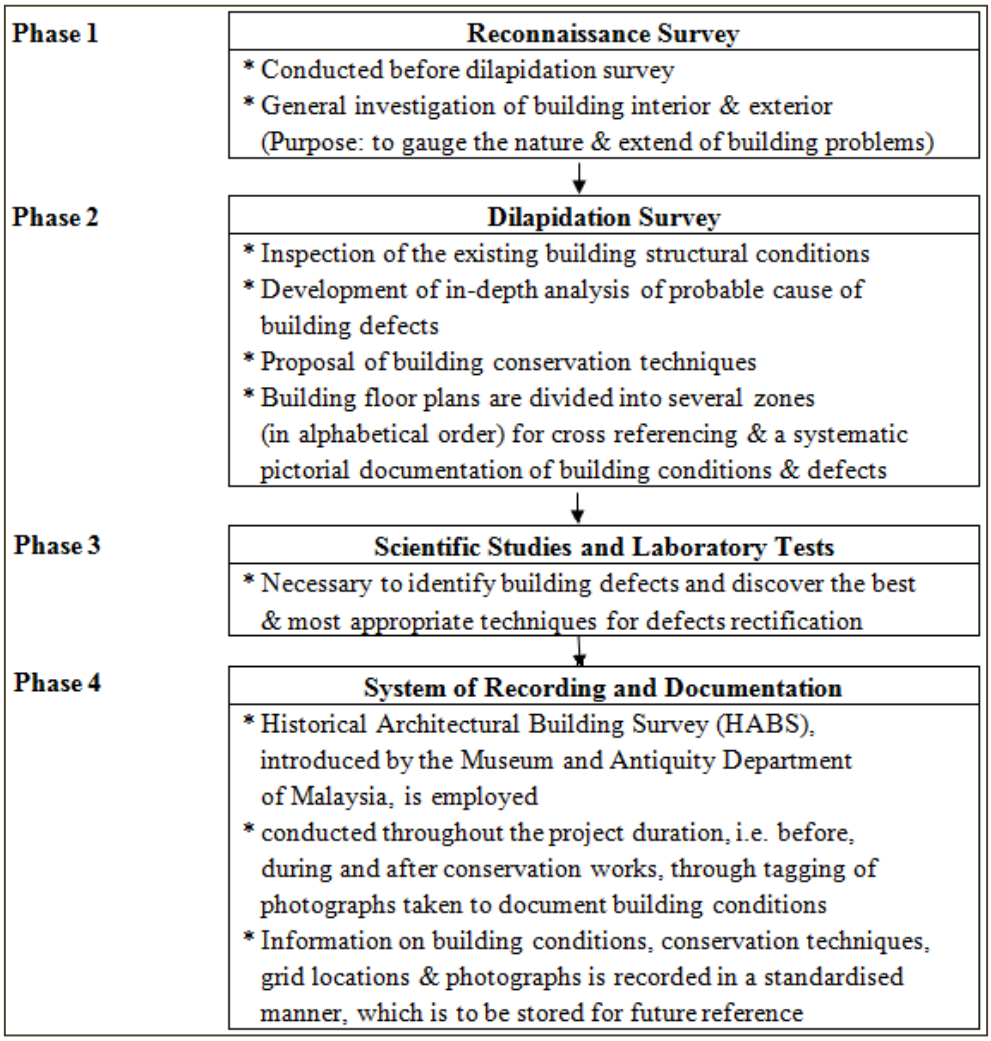

Figure 9: Conservation practice adopted in Hotel Majestic refurbishment project

EXISTING BUILDING DEFECTS

Despite the rich legacy of historical events that had taken place at Hotel Majestic Kuala Lumpur prior to its conversion of function which housed the National Art Gallery in 1980's, the building has inevitable signs of age. Unfortunately, the building has begun to deteriorate after ceasing to house artworks when the National Art Gallery moved to its new home at Jalan Tun Razak. Such absence of attention towards the conservation of Hotel Majestic, coupled with the visible building defects, has raised concern of many that the nation would suffer the loss of yet another well-established sight in this historic part of the city.

Wan Hashimah and Associate Professor Dr. Shamsuddin (2005) quoted from Jokilehto (1999) on the fact that these built heritage properties are under the threat of extinction, and the danger would continue to exist if care is not assumed to protect these buildings against deterioration due to weather, ageing process, consumption by

use and natural disaster. When the hotel was being proposed for refurbishment which started approximately in May 2011, it was of no surprise that many building defects were found during dilapidation survey.

ISSUES OF DEFECTIVE PLASTER RENDERING

One of the conservation principles explicated by Ahmad (2006) is to minimise the disturbance towards the heritage buildings. The minimal intervention could be performed by preserving the fabric of the building façade to its originality as much as possible, so that there is a blend of harmonious sense between the old building material and the new one.

In order to determine the components of the previously applied plaster back in the 1930s, samples of 300mm × 600mm plasters at three selected walls of the hotel were being transported to the laboratory at *Universiti Sains Malaysia* (USM) for testing via X-ray Fluorescence (XRF) spectrometer. This is a non-destructive method of analysis for building materials components which works on wavelength dispersive spectroscopic principles. As all atoms react differently towards the radiation, components of the plaster were able to be identified.

Element	Block A (W1)	Block A (W2)	Block A (W3)
Al_2O_3	3.864	5.002	6.734
SiO_2	56.445	52.862	62.745
CaO	26.945	28.440	18.056
LOI	9.38	10.41	8.69

Table 1: Building Material Components in Percentage through XRF Test Analysis (Hotel Majestic Kuala Lumpur) (Source: YTL Majestic Hotel Sdn. Bhd.)

From the results gathered from USM (Table 1), it was made known that the main elements present in the sample of plasters that were being sent for testing constituted of sand, lime and water and Ordinary Portland Cement (OPC), following the descending sequence in the table above. From the percentage breakdown of the main compositions detected (Figure 10), the project conservators were able to deduce several types of plaster mixing ratio that were applied prior to the current refurbishment works. Proposed plaster rendering mixtures based on the deduction were then being applied at the affected walls to see their chemical reaction with the walls.

It was deduced that the previously applied plaster mixing ratio constituted of sand:lime:water. The conservators from Jabatan Warisan Negara concluded that comparatively to the main plaster elements, the presence of Ordinary Portland Cement (OPC) was almost negligible. Moreover, it was unlikely that the trifling percentage of cement once formed a part of the constituents that were mixed for plaster rendering

back in 1932. Hence, OPC was being left out from the proposed plaster mixing ratio, as its characteristics did not match that of the original plaster rendering mix.

One of the limitations of the XRF analysis is its inability to determine the particle size and shape of the components discovered. Thus, mock-ups have to be applied according to the several proposed plaster mixtures at the affected walls for trial purposes.

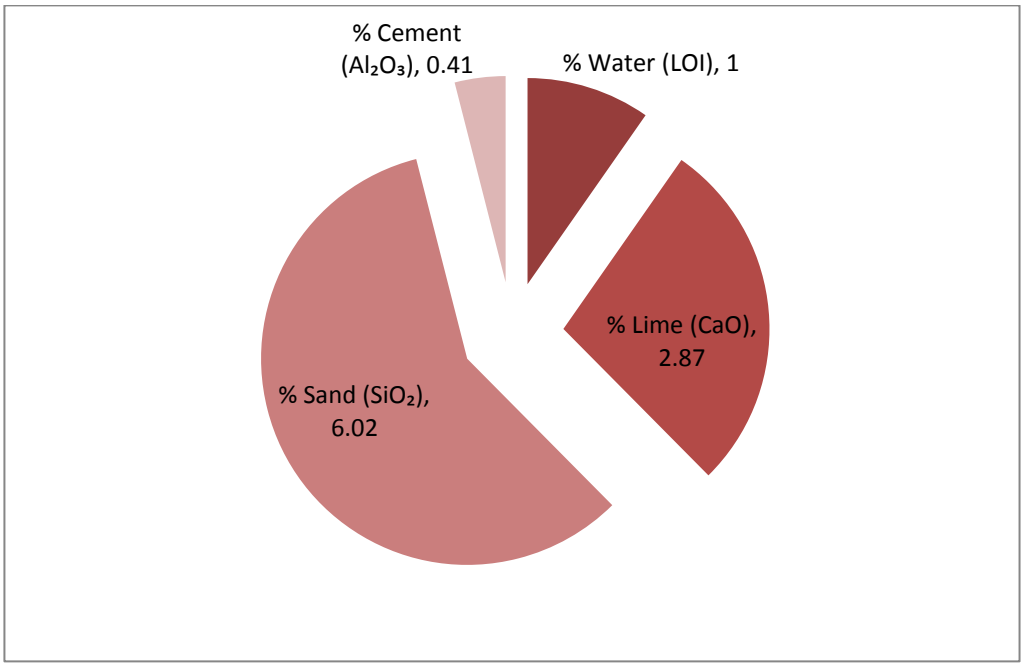

Figure 10: Breakdown of Plaster Components based on XRF Test Results (Block A, W1) (Source: YTL Majestic Hotel Sdn. Bhd.)

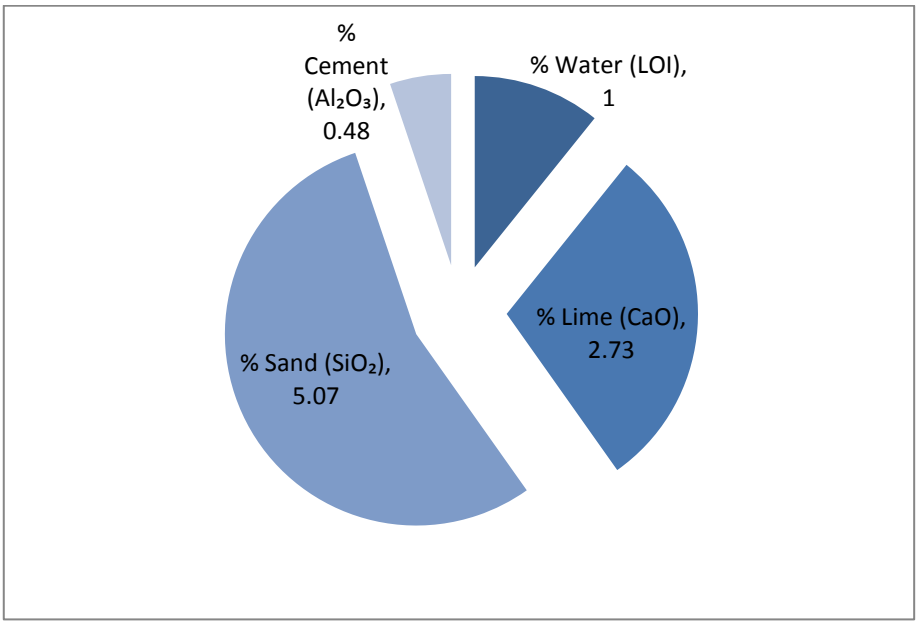

Figure 11: Breakdown of Plaster Component based on XRF Test Results (Block A, W2) (Source: YTL Majestic Hotel Sdn. Bhd.)

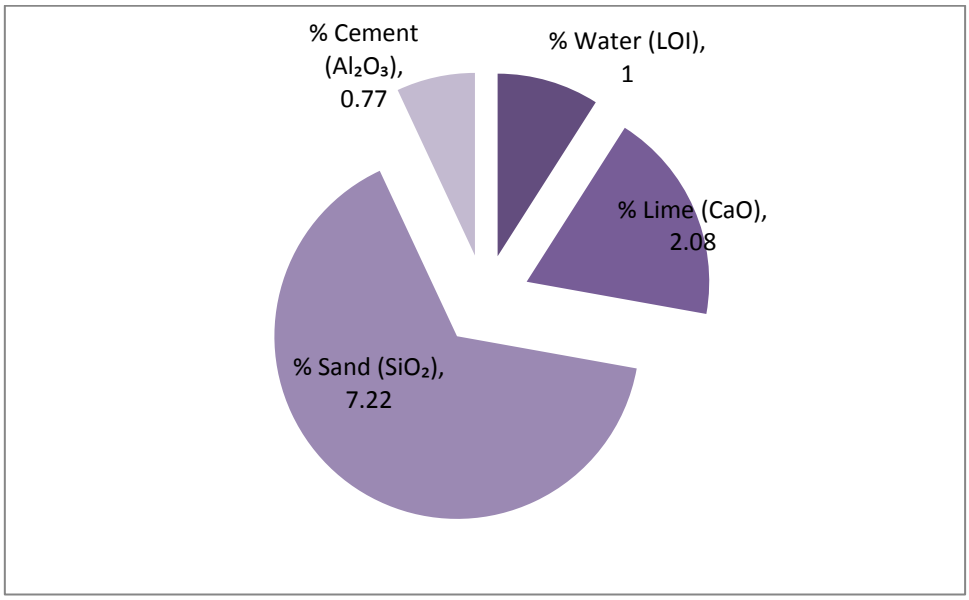

Figure 12: Breakdown of Plaster Component based on XRF Test Results (Block A, W3) (Source: YTL Majestic Hotel Sdn. Bhd.)

Figure 11 and Figure 12 give the breakdowns of two different plaster samples that were being sent for laboratory testing. A closer look at Figure 10, Figure 11 and Figure 12 show that these ratios are more or less the same.

Having identified the breakdowns, first round of mock-up samples were being applied based on the proposed plaster rendering mixtures as suggested by the conservators of

the project. After 28 days of application of these mixtures, visual investigation was carried out to see the integrity of the proposed mixture and the affected wall with naked eyes. Having rejected those with cracks and rough finishing, the remaining samples were being selected for second round of mock-up preparation, whereby same plaster rendering mixtures were being applied, except with the addition of an addictive called *Powerpuzz Pozzolan* in this round.

Basically, newly proposed plaster rendering ratios are summarised in Table 2.

Item	% Water (LOI)	% Lime (CaO)	% Sand (SiO_2) Fine sand + Coarse sand	% Additive Powerpuzz Pozzolan
Proposal 3	1	2	4 + 3	1.0
Proposal 4	1	2.5	4 + 2	0.5
Proposal 6	1	2	3 + 3	1.0
Proposal 7	1	1.5	2 + 1	0.5

Table 2: Plaster Ratio based on 1st Mock-up Results (7/7/11) (Source: YTL Majestic Hotel Sdn. Bhd.)

(Note: The plaster ratio of proposal 1, 2 and 5 were not selected as the mock-up results revealed the occurrence of cracks and unsuitability of blending in with the affected walls.)

New sets of mock-ups were then prepared according to five different plaster ratios. Based on the observation and suitability of the material on the building fabric, the conservators suggested the addition of natural addictive for this round of mock-ups. The use of this addictive, *Powerpuzz Pozzolan (metokaolin)*, not only helps to achieve a smooth surface finishing, it also results in less appearance of cracks. Again, the ratios were tabulated, see Table 3:

Item	% Water (LOI)	% Lime (CaO)	% Sand (SiO_2) Fine sand + Coarse sand	% Additive Powerpuzz Pozzolan
Sample 1	1	2	4 + 3	1.0
Sample 2	1	2.5	4 + 2	0.5
Sample 3	1	2	3 + 3	1.0
Sample 4	1	1.5	2 + 1	0.5
Sample 5	1	2	2 + 2	0.5

Table 3: Newly Proposed Plaster Ratio with the Addition of Powerpuzz Pozzalan (Source: YTL Majestic Hotel Sdn. Bhd.)

After 28 days had elapsed to allow the setting of plaster, its compressive strength was being tested using *rebound hammer* method (Figure 13 and Figure 14). Generally, results revealed that the overall strength achieved was generally low. The highest average compressive strength was 4.8kN/mm². Hence, based on the highest compressive strength achieved and the ability to harmonise well with the building façade, the best plaster mix, which is sample 5, was selected to be applied to the walls of the hotel (Table 4).

Item	% Water (LOI)	% Lime (CaO)	% Sand (SiO_2) Fine sand + Coarse sand	% Additive Powerpuzz Pozzolan
Sample 5	1	2	2 + 2	0.5

Table 4: The Best Plaster Ratio Chosen (Mock-up on 28/7/11) (Source: YTL Majestic Hotel Sdn. Bhd.)

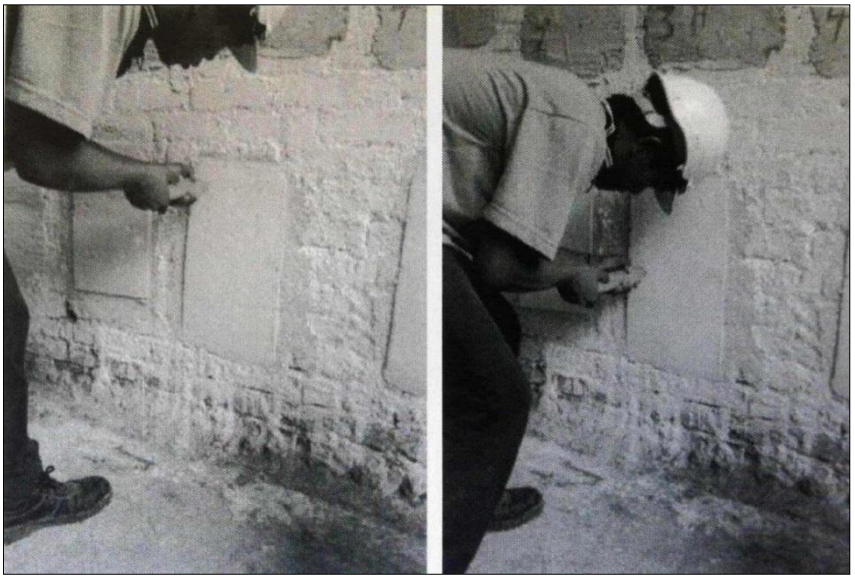

Figure 13: Testing on Mock-up Samples Applied with Powerpuzz Pozzolan (Source: YTL Majestic Hotel Sdn. Bhd.)

Figure 14: Two Samples being tested with Rebound Hammer
(Source: YTL Majestic Hotel Sdn. Bhd.)

Having determined the most suitable plaster mix ration to be applied on the affected walls of Hotel Majestic, a 300mm × 600mm of sample 5 plaster sample was sent to USM for verification of the similarity between the original plaster and the current plaster. Such results are needed in order to document the proof of compliance with regulations for Class III heritage conservation works.

CONCLUSION

In elevating the people's concern for conservation of historic buildings, this paper exhibited the 'mise en valuer' concept in refurbishment works of Hotel Majestic Kuala Lumpur. From the ground research, one understands that the refurbishment project was being classified as Class III conservation works, limited to retention of building façade only. Through the dilapidation survey, the conservators were able to identify the degree of dilapidation in the building. Samples from the affected parts of the hotel were being sent for laboratory testing in attempt to identify the plaster materials used originally. From then, with the knowledge of the architectural style used in 1932 coupled with the laboratory test results, the conservators were able to advise the in-house contractors from YTL Majestic Hotel Sdn. Bhd accordingly. Details of the refurbishment process of the building façade, i.e. repairs of defective plaster rendering, were discussed. There is a popular Malay axiom in Malaysia that goes, '*Melentur buluh biarlah dari rebungnya*.' Just like a bamboo stalk, it is easier to mould the characteristics of a child at younger age. Though there is growing awareness to conserve the historic buildings and sites since the joint inscription of Georgetown and Malacca as UNESCO World Heritage Site a few years back, the general alarmingly high statistics of dilapidated heritage buildings in Malaysia still warrant for immediate attention for prevention from further decay. The nation should educate the younger generation to ensure that they understand the measures which the

present generation has done for the care of these valuable heritage properties and continue to practice it in their era. Just as Hardy (2008) has quoted from ICOMOS (1965), these heritage monuments are imbued with the age-old traditions. It is only fair that everyone does their fair share in safeguarding them so as to hand them on to future generation in their full richness of authenticity.

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A REVIEW OF METHODS USED TO CONTROL TERMITES IN BUILDINGS IN MALAYSIA

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ABSTRACT

Termite infestation is a major problem that occurs in residential buildings in Malaysia. Lee (2002) reported that about 70% of termite treatments were done on residential areas, 20% on industrial buildings and 10% on commercial buildings. Many house owners are unaware of the various methods used for termite treatment available in the market. Though maintenance is part of the building life cycle, the property damage caused by termite infestation accelerates the need for repairs. The presence of termites warrants the need for periodic inspection and treatment. Besides incurring financial loss due to additional expenditure on repair costs, house owners suffered from constant psychological stress due to damage to buildings caused by termite attack, which could both be structural and non-structural in nature. To minimize damage from termites, it is useful to know the signs of termite infestation, as well as preventative and control measures. This article attempts to identify the various termite treatment methods available commercially at present and the effectiveness of these treatment methods based on a recent questionnaire survey carried out among pest management professionals. It will help the house owners to make a more informed purchasing decision.

Keywords: Baits, infestations, termites, treatment methods

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INTRODUCTION

Buildings are constructed to provide security, safety, protection and comfort for occupants and their possessions. Most of the residential buildings found in rural areas, such as new villages and kampongs, and small towns in Malaysia are constructed of timber. In bigger towns and cities, even for reinforced concrete buildings, a substantial proportion of building components such as door frames, window frames and roof trusses are still made of timber. Timber, made up of various organic compounds, is the only building material which is prone to destruction by biological agencies such as fungi and insects, as it contains cellulose and starch which are food for these attacking agents (Wong 2007:74). Termites are the primary insects which are capable of initiating attack in dry wood in service, and they cause the greatest structural damage to buildings (Wong 2007:76). They are considered as pests because they adversely affect human's well-being or economy. The National Association of Forest Industries (NAFI 2003), Australia, reports that in areas where termites are found, they can be a threat to the safety of the structure, building contents and amenities of the building for occupants and their possessions. Termites are prevalent in Malaysia, a country located in the tropics, and many buildings in Malaysia are infested with termites. NAFI (2003) mentions that the presence of termites is a function of climate and the closer a region is to the tropics the greater is the risk of termite attack. The distribution of the termite covers the tropical and subtropical areas between the latitudes 45° North and 50° South (ENVIROCON 2007). Based on data from clients, compiled since 2002, 46% of properties monitored by Ridpest® were attacked by termites at least once over a period of four years, with the detailed breakdown as follows: 32% of these properties were attacked once, 8.5% twice, 2.3% thrice, and 3.2% for more than 3 times during the same four-year period (StarSpecial, 2007). In an unpublished survey to measure the extent of termite infestation at various locations in Kepong and Kuala Lumpur carried out by the Forest Research Institute of Malaysia (personal communication to the first author), it was found that almost 67% of the wooden structures and buildings under survey showed subterranean termite activity. To minimize damage from termites, it is useful to know the description, the signs of termite infestation, as well as preventative and control measures (Gold et al. 1999:1). There are numerous local professional pest management companies offering their termite treatment services commercially. Recently there has been high numbers of commercials targeting Malaysian house owners regarding termite problems and treatment methods.

The aims of this article are to:

- identify the different parts of buildings which are commonly infested by termites,
- identify the various termite treatment methods available locally at present, and
- investigate the effectiveness of these treatment methods in controlling termites.

LITERATURE REVIEW

Termites are amongst the most damaging insects as they feed on any biodegradable cellulose products which they manage to find, land on or live in. They have protozoa in their intestines which provide enzymes to digest cellulose (Kamble 2006). About 2753 species of termites have been identified worldwide, comprising of 285 genus and 7 families, of which more than 150 species are known to damage wood in buildings and other structures (Richardson 1995). Termites in Malaysia are represented by three families, namely, Kalotermitidae, Rhinotermitidae and Termitidae, totalling 175 species from 42 genera (Tho 1992). Only 10% of these species are classified as structural pest of economic importance. The most destructive are from the genus Coptotermes, of the family Rhinotermitidae. The five common species fall under this genus are C. travians, C. curvignathus, C. kashorverni, C. sepangensis and C. havilandi (Lee 2002; ENVIROON 2007).

Worldwide, there are three ecological groups of termites, namely, subterranean, drywood and dampwood termites, of which the subterranean termites are the most destructive (Peterson et al. 2006). The two most common types of termites found in Malaysia are the subterranean termites and drywood termites (Wong 2007:76), with the former being encountered more frequently. Termites require three things to survive, namely, food, a moderate tropical environment and a constant source of moisture. Soil is conducive as the dwelling place for subterranean termites, as it serves as a source of moisture which protects termites against drying out and shields them from predators (Matthews & Kitching 1984). Termites are attracted to odours of wood-decaying fungi that, through the decay process, make the wood easier to penetrate (Gold et al. 1999). When termites are found to infest a building, they may present aesthetic objections, significant risks to health, deterioration of the structure itself and economic loss (Murphy and Todd 1996:9). The amount of damage termites can cause to a wooden building structure depends on the following factors:

1. Colony size: The more termites that feed on the wooden building structure, the more damage they can cause. The maximum size of a colony depends on location, food availability and environmental conditions, especially temperature and moisture (Gold et al. 1999:3).
2. Duration of feeding: The longer the wooden building structure has been attacked, the greater is the damage. Based on normal termite feeding activity, it takes 3 to 8 years to cause appreciable damage (Kamble 2006).
3. Types of termites: In terms of economic loss, the most destructive insect to attack timber buildings is the subterranean termite. Subterranean termites contributed 80% of damage in Malaysia (ENVIROCON 2007).

Financial Impact

The negative impact of termites is often cited in economic terms as expenditures for damage, repair and preventative treatment costs. In Malaysia, including the states of Sabah and Sarawak, termites are often regarded as causing more visible destruction to forest trees and wooden structures than, perhaps, any other tropical insect groups.

Subterranean termites are responsible for most of the termite damage caused annually in Malaysia. Mr. Richard Ng, Managing Director of NCL General Pest Control Sdn. Bhd., opined that the expenditure for repair of damage and preventative treatment increases by 10% to 20% annually. According to James Tan, Associate Director of Raine & Horne International Zaki and Partners Sdn. Bhd., there would be a reduction of between RM 5000 and RM 10000 (approximately £1000 -£2000) in the price of a house it was infested with termites (Property Times 2004). In Malaysia, termite control accounted for 50% of the total business turnover of the pest control industry in 2000 (Yeoh & Lee 2007). About 70% of termite treatments were carried out on residential premises, 20% on industrial buildings and 10% on commercial buildings (Lee 2002). In the United States, the property damage caused by termites was more than the damage caused by fire and windstorm combined. Gold et al. (1999) reported that the damage caused by termites in the United States was more than USD 2 billion each year. An analysis carried out in the year 2003 by the National Pest Management Association, United States of America, reported that the total amount of the cost of damage and treatment worldwide were approximately USD 5 billion.

Detection Techniques

Subterranean termites have a "cryptobiotic" or hidden lifestyle, which contributes to their success in invading wooden building structures (Miller 2001). They always hide themselves from human view either beneath the surface of the soil, beneath the surface of the wood, or in their mud tunnel. However, evidence of subterranean termite infestations can be detected by the following 3 indicators (Kamble 2006; Gold et al. 1999; StarSpecial 2007):

a) mud tubes, shelter tubes or termite trails: subterranean termites "nest" in the soil and from there they can attack structures by building mud tubes from the soil to the wood fixtures in structures. Mud tubes, shelter tubes or termite trails could be found on walls, small gaps in wooden floor skirting, door frames, window frames and other wood-filled areas which had been attacked by termites, before they moved up to the roof truss. A dry mud tube is most probably inactive. However, if it is still active and is broken, it will be rebuilt as worker termites travel periodically via mud tube to their nest to regain moisture and perform feeding duties. Mud tubes are solid evidence of termite activity.
b) swarmers: termites often come out from their hiding place at the onset of a warm weather. A particularly warm day, during a cool period may trigger small-winged termites, called swarmers, to emerge. House owners do not usually detect the presence of subterranean termites until termite swarming takes place.
c) wood damage: the presence of cracks and holes in wooden fixtures indicates wood which has been attacked and damaged by termites. Knocking with a screwdriver may indicate hollowness. If the colony is still active, termites are found in the infested wood, which will produce a 'tick-tick-tick' sound as they tear and break wood fibres. When the termites are

disturbed, soldier and worker termites may bang their heads against the tunnels to produce sound as a mean of communication to mobilize the colony to defend itself. Another sign for the probable presence of termites is the change of colour or texture of damaged wooden fixtures.

The professional pest management companies may use the following additional equipment to help in their inspection for subterranean termites (Kamble 2006), namely:

a) moisture meter: a moisture meter can detect increased moisture levels in the mud tubes hidden behind walls, as well as high moisture conditions that encourage subterranean termite infestation (Gold et al. 1999:5). The moisture meter determines the moisture content of surrounding areas and gives the operator an indication if termites are likely to be active.
b) Termatrac®: Termatrac® is an inspection tool which is able to track the extent of termite activity without disturbances, track termites to entry point, locate termite nests via entry point and determine the most suitable treatment procedures. It was invented and developed in Australia using technology similar to radar.
c) PestFinder®: termites are moist and in constant motion. These two characteristics are used by PestFinder® for the detection of termites from remote places. PestFinder® uses light pulses and digitally processes the signal to indicate the location of termites.
d) acoustical emission device.
e) borescope: infrared camera, which is used to check for termite presence in electrical and plumbing service runs.
f) microwave motion detector: a method for confirming the presence of termites in a structure, involving a preliminary infrared scan of a structure and confirmation of termite infestation with at least one detector in order to quickly locate potential areas of termite infestation.

Preventative Measures

The basic principle behind prevention is to deny termite access to wood (as food for termites), moisture and shelter (Gold et al. 1999:6). Wong (2007:77) opined that the best solution is to prevent the entry of termites into the building structure by taking extra careful steps during the construction stage and to keep a constant lookout for any signs of attacks. This can be achieved:

a) by eliminating conducive conditions such as:
    i. eliminating all wood-to-soil contacts as studies have shown that about 90% of structural termite infestation can be traced to wood that is in contact with the soil. Wood-soil contact provides termites an easy access to food and water from the soil and frequently, a hidden way into the structure.
    ii. removing wood debris left on or below the soil surface which provide a convenient source of food for termites.

iii. removing dense vegetation from the sides and foundation of the house which traps moisture. Dense vegetation also makes the inspection and detection of termite presence more difficult.
iv. eliminating moisture problems.

b) by installing termite shields, which are lengths of non-corroding metal sheets being carefully overlapped and soldered to form a continuous shield around the concrete or solid masonry walls and structural wood. Termite shields will not protect a structure from termites, but force termites to tube around them where the mud tubes will be more visible. To be useful, regular inspections and additional control methods are needed.
c) by using termite resistant materials, such as pressure-treated wood, aluminium or stainless steel. Pressure-treated wood is frequently used in the construction of buildings and provides effective termite control if wood comes within 150mm to 300mm of the soil, up to the ceiling level of the first floor. Commercially, aluminium has been used widely as window and door frames, stainless steel being used for kitchen cabinets and steel being used for roof truss construction to replace the traditional timber.

Treatment Methods

To control termites, it is almost inevitable to use pesticides. Pesticides used specifically to control termites are called termiticides. Termiticides, either repellent or non-repellent, may be applied as liquids or baits. From review of literature, the following methods of treating structures are available:

a) foundation treatment, which involves the application of termiticides to foundation elements to create a barrier and placing termiticides inside of concrete block/brick walls where voids exist.
b) wood treatment, which involves the applications of termiticides directly to wood to eliminate existing infestations. Spraying termiticides on the wood already in place provides only surface protection. In damaged wood, termiticides can be injected into the cavities, which provide better control than brushing or spraying application.
c) soil treatment, which involves the application of liquid termiticides to soil to create a continuous chemical barrier around and beneath the structure in order to block all potential routes of termite entry (Myles 2004). Termites attempting to penetrate through the treated soil are either killed or repelled. The conventional treatment methods for foundation, wood and soil entail the use of highly toxic and persistent termiticides which are risky to house owners, detrimental to indoor air quality, and polluting to the environment (Myles 2004). Moreover, the effectiveness of chemical barrier is dubious, as the treatments attempt to block the movement of termites within the soil without eliminating the pests. As a result, termite populations can continue to grow. The use of chlorinated hydrocarbons such as DDT, aldrin, dieldrin and chlordane as liquid termiticides was subsequently discontinued. Repellent termiticides such as permethrin, cypermethrin and

deltamethrin, which are still available for use, are synthetic pyrethroids. Non-repellent termiticides such as Premise® and Termidor®, which kill termites, comprise the majority of liquid termiticides in use today.

d) bait/monitoring systems, which involve the application of non-repellent termite baits, which usually consist of paper, cardboard, or saw-dust material containing active ingredients that kill termites, thereby eliminating or reducing the size of the termite colony. The earliest bait, registered in 1994, contains an active ingredient known as insect-growth regulator (IGR) which inhibits the growth of chitin (the main component of the insect exoskeleton) during the growth process known as moulting, thereby killing immature termites. Currently, termiticide baits are either IGRs or slow acting stomach poisons which interfere with termite cellular energy-production activities, thereby killing them slowly. A list of subterranean termite bait systems currently available in the United States, with the active ingredients, is given in Table 1. There are two types of bait stations, above ground and in-ground (Cabrera et al. 2002). Above ground stations are installed directly over sheltered tubes or infested wood so that termites can begin to feed immediately on the bait. In-ground stations are placed in the soil. Most in-ground stations are cylindrical tubes with numerous holes or slots through where termites can enter to get to the wood and bait inside and with disc tops to make them easier to find and keeps them from sinking into the ground. Use of termite bait system requires manufacturer-sponsored training and it is available only to licensed professional pest management companies, except Terminate®, which is available to house owners as a "do-it-yourself" bait product. Periodic monitoring and inspection of bait stations is critical to the system's effectiveness.

RESEARCH METHODOLOGY

A questionnaire survey was used for the purpose of collecting quantitative data. The survey questionnaire consisted of 5 sections. Section 1 elicited information about the background of the pest management companies. Sections 2, 3 and 4 contained questions, respectively, related to physical treatments, chemical treatments and baiting systems against termite infestation. Section 5 enquires about the degree of termite infestation in different parts of a building and according to the geographical location of the building. A total of 44 pest management companies registered with Pesticides Board, Ministry of Agriculture Malaysia were identified and contacted to request their participation. Of the 36 pest management companies in the Klang Valley, 30 confirmed their willingness to participate in the survey. All the pest management companies from Penang and Kedah confirmed their participation. The questionnaires were then distributed to the respondents by means of mail, telephone, in-person interview, facsimile and email on 24th September 2007. The numbers of completed questionnaires received as of 5th October 2007 are shown in Table 2. Only 8 questionnaires were received from the companies located in the Klang Valley, and 3

questionnaires were returned by the companies from Penang with one further return from the sole company from Kedah. The average response rate is 31.6%.

Subterranean Termite Bait System	Active Ingredient	How it kills termites	Above-ground Monitoring Stations	In-ground Monitoring Stations	Can it be Used Without Termiticides
Extrrra® Termite Interception and Baiting System	Diflubenzuron (IGR)	Prevent formation of cuticle	Yes	Yes	Yes
First Line® Termite Defence System	Sulfuramid	Stomach poison	Yes	Yes	Yes
Advance® Termite Bait System	Diflubenzuron (IGR)	Prevent formation of cuticle	No	Yes	Yes
Sentricon® Colony Elimination System	Hexaflumuron (IGR) Noviflumuron (IGR)	Prevent formation of cuticle	Yes	Yes	Yes
Subterfuge ® Termite Bait	Hydra-methylnon	Stomach poison	No	Yes	Yes
HexProTM Termite Baiting System	Hexaflumuron (IGR)	Prevent formation of cuticle	Yes	Yes	Yes
Termitrol® Bait System	Disodium Octaborate tetrahydrate	Stomach poison	Not mentioned	Yes	No
Terminate®	Sulfuramid	Stomach poison	No	No	No

Table 1: Subterranean Termite Baiting Systems (Main source: Cabrera et al. 2002)

DATA ANALYSIS AND RESULTS

Table 3 tabulates the background information about the 12 pest management companies participated in the survey. All of the respondents were in managerial positions. They have been in business for 4 to 36 years, serving an estimated 40,600 clients (based on the responses for 11 of the 12 companies). The estimated total annual cost spent on termite treatment, as obtained from 10 respondents, is about RM 6,272,000 (approximately £1,300,000) as of the date the survey was carried out. Based on the services carried out for their clients (average for 10 pest management companies) the estimated extent of termite infestation was about 43.5% in rural areas, 23% in small towns, and 33.5% in towns.

Geographic region	Klang Valley		Penang		Kedah	
Number of companies contacted	36		7		1	
Number of companies initially agreeing to participate	30		7		1	
	Date sent	Date received	Date sent	Date received	Date sent	Date received
Mode	24-9-2007	5-10-2007	24-9-2007	5-10-2007	27-9-2007	5-10-2007
By mail	28	5	4	0	0	1
By telephone	1	1	0	0	0	0
By in-person interview	0	0	2	2	0	0
By facsimile	0	1	1	1	1	0
By e-Mail	1	1	0	0	0	0
Total	30	8	7	3	1	1
Response rate (%)	26.7		42.8		100.0	
Average response rate (%)	31.6					

Table 2: Breakdown of Questionnaires Sent and Received

Nearly all the 12 pest management companies provide inspection, detection and treatment services for termite infestations. The treatment methods available include both the chemical and baiting system. Only 3 of the 12 pest management companies, as given in Table 4, provide physical methods for the prevention of termite infestation Nine of the respondents opined that the baiting system is more effective than the chemical method. In is interesting to note that two main termite baiting systems are currently available in Malaysia, namely, Exterra® and Sentricon®, as given in Table 5. The other baiting system is Termitube® from Australia. The two chemicals used in each of the two baiting systems are, respectively, Chlorfluazuron and Hexaflumuron. One respondent used Imidachloprid in the Exterra® baiting system for termite treatment. The three main non-repellent chemicals used in chemical soil treatment for termite prevention include are Chlorpyrifos, Imidacloprid, Fipronil. Ten of the respondents opined that the non-repellent chemicals used in the chemical treatment for termite prevention are more effective.

Company Code and Position of respondent	Established in (Year) and Location	Estimated Number of Clients	Estimated Total Annual Cost (RM)	Estimated extent of termite infestation (%)		
				Rural areas: villages and kampongs	Small Towns	Towns/ Cities
#1 Director	1997 K. Lumpur	2000	1,500,000	70	20	10
#2 Director	1972 K. Lumpur	30000	1,200,000	5	15	80
#3 General Manager	1996 K. Lumpur	>1000	300,000	30	30	40
#4 Principal	2000 Penang	150	200,000	40	30	30
#5 Branch Manager	2002 Penang	50	100,000	60	20	20
#6 General Manager	1985 K. Lumpur	1800	NA	20	20	60
#7 Sales Manager	NA Penang	NA	NA	70	15	15
#8 Managing Director	1990 Penang	1500	900,000	60	20	20
#9 Sales Manager	1996 K. Lumpur	500 - 600	700,000	30	30	40
#10 Sales Manager	2003 K. Lumpur	1500	72,000	Not Available		
#11 General Manager	2004 K. Lumpur	100	200,000	50	30	20
#12 Not indicated	1985 Not indicated	2000	1,100,000	Not Available		
	Total =	40,600	6,272,000	43.5%	23%	33.5%
			Average =			

Table 3: Estimated Total Annual Cost and Extent of Termite Infestation (The respondent from Kedah indicated the location as Penang)

Company Code	Techniques Available			Treatment Methods Available			Which is more effective, chemical or baiting system?
	Inspection	Detection	Treatment	Physical	Chemical	Baiting system	
#1	Yes	Yes	Yes	No	Yes	Yes	Baiting system
#2	Yes	Yes	Yes	No	Yes	Yes	Chemical treatment
#3	No	No	Yes	Yes	Yes	Yes	Baiting system
#4	Yes	Yes	Yes	No	Yes	Yes	Baiting system
#5	Yes	Yes	Yes	No	Yes	Yes	Chemical treatment
#6	Yes	Yes	Yes	No	Yes	Yes	Baiting system
#7	Yes	Yes	Yes	No	Yes	Yes	Baiting system
#8	Yes	Yes	Yes	No	Yes	Yes	Baiting system
#9	Yes	Yes	Yes	No	Yes	Yes	Baiting system
#10	Yes	Yes	Yes	Yes	Yes	Yes	Baiting system
#11	Yes	No	Yes	Yes	Yes	Yes	Chemical treatment
#12	Yes	Yes	Yes	No	Yes	Yes	Baiting system

Table 4: Termite Treatment Methods Available Commercially

The extent of termite infestation in different parts of timber and reinforced concrete buildings are tabulated in Tables 6 and 7 respectively. For both cases, the building components commonly affected by termite infestation are roof trusses, parquet floors, window frames, door frames, and built-in furniture. These results tally with the results presented by Lee (2002:5) which were obtained from 10 pest control companies.

Company Code	Chemicals used for Chemical Soil Treatment			Baiting System	
	Repellent	Non-Repellent	Which is more Effective?	System	Chemical
#1	Bifenthrin,	Imidacloprid	Non-repellent	Exterra® (with Requiem® as termite bait)	Chlorfluazuron
#2	Deltamethrin, Cypermethrin, Permethrin.	Chlorpyrifos, Imidacloprid, Fipronil, Fenobucarb.	Non-repellent	Exterra®, Termitube®	Not Available
#3		Chlorpyrifos	Repellent	Not Available	
#4		Chlorpyrifos, Preminator, Fipronil, Premise 200SE,	Non-repellent	Exterra®	Chlorfluazuron
#5		Chlorpyrifos	Non-repellent	Exterra®	Chlorfluazuron
#6		Chlorpyrifos, Imidacloprid	Repellent	Sentricon®	Hexaflumuron
#7		Chlorpyrifos, Fipronil, Imidacloprid	Non-repellent	Sentricon®	Hexaflumuron
#8	Bifenthrin	Chlorpyrifos, Imidacloprid	Non-repellent	Exterra®	Chlorfluazuron
#9		Chlorpyrifos, Imidacloprid	Non-repellent	Exterra®	Imidachloprid
#10		Chlorpyrifos, Imidacloprid	Non-repellent	Exterra®	Chlorfluazuron
#11		Chlorpyrifos, Imidacloprid	Non-repellent	Sentricon®	Hexaflumuron
#12		Chlorpyrifos, Fipronil, Imidacloprid	Non-repellent	Sentricon®	Hexaflumuron

Table 5: Chemicals used for Chemical Treatment and Baiting System

Company Code	Parts of timber buildings commonly infested with termites							
	Roof truss	Columns	Walls	Slabs/floors/parquet	Window frames	Door frames	Built-in furniture	Others (Please state)
#1	√		√		√	√	√	
#2		√		√	√	√		Timber panels
#3	√		√		√	√	√	Wood panels, stores
#4	√				√	√	√	
#5	√				√	√	√	
#6	√			√	√	√	√	
#7	√			√	√	√	√	
#8	√		√		√	√	√	Electrical conduits
#9	√	√	√	√	√	√	√	Stand-alone furniture
#10	√	√	√	√	√	√	√	Stand-alone furniture
#11	√			√	√	√	√	Stand-alone furniture
#12						√		

Table 6: Parts of Timber Buildings Affected by Termite Infestation

Company Code	Roof truss	Columns	Window frames	Door frames	Built-in furniture	Others (Please state)
#1	√		√	√	√	
#2			√	√	√	Parquet flooring
#3	√		√	√	√	Wooden floor-boards
#4	√		√	√	√	
#5	√	√	√	√	√	
#6	√			√	√	
#7	Not Available					
#8	√		√	√	√	Riser rooms
#9	√	√	√	√	√	Stand-alone furniture
#10	√	√	√	√	√	Stand-alone furniture
#11			√	√	√	Stand-alone furniture
#12				√		

Table 7: Parts of R.C. Buildings Affected by Termite Infestation

CONCLUSIONS

All the 12 pest management companies participated in the survey provide both the chemical and baiting treatment methods for termite infestation. There are currently

two main termite baiting systems available in Malaysia, namely, Exterra® and Sentricon®, according to this survey. From the results shown in Table 3, the estimated extent of termite infestation based on locality is 43.5% in rural areas such as villages and kampongs where the buildings are predominantly still made of timber, 23% in small towns and 33.5% in towns or cities. These figures, however, should be backed up by actual data rather than perceptions of respondents on the estimated number of their clients or estimated total annual cost.

It is reported by University of Nebraska-Lincoln (2006) in the handbook for homeowners that the newer non-repellent termiticides are more effective than repellent termiticides for treatment of termite infestation and despite chemical barrier treatment, continues to be the most common procedure used for controlling subterranean termites, with termite baiting system becoming more popular. The results in Table 4 show that both methods, i.e. chemical barrier treatment and termite baiting system are commonly used in Malaysia. However, nine out the 12 respondents opined that the baiting system is more effective. This mirrors the growing popularity of the baiting system in USA.

The building components commonly affected by termite infestation, for both timber and reinforced concrete buildings, are roof truss, parquet floors, window frames, door frames and built-in furniture. These results tally with the results presented by Lee (2002:5). However, the results shown in Tables 6 and 7 would be more significant if ranking of the extent of infestation or impact of infestation on structural integrity of buildings was available. Future research could be carried out to investigate both aspects.

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E-TENDERING IN MALAYSIAN CONSTRUCTION INDUSTRY

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ABSTRACT

This study investigates the potential of construction organisations to participate in e-tendering in the Malaysian construction industry. Using a postal questionnaire survey, the opinions of the contractors from class A to class D were assessed and it was found that the majority of contractors are satisfied with the current traditional tendering process. The greatest dissatisfaction with traditional tendering was the labour intensity required to issue and respond to tender. The perceived benefits and challenges of e-tendering were also evaluated. The three most important benefits of e-tendering were identified as 'Reduction in Overhead Cost', 'Overcome Geographical Limitation' and 'Saving in Storage Space' while 'Poor Reliability', 'Resistance to Change' and 'Security Concerns' are the three most important challenges of e-tendering. The contractor's readiness to adopt e-tendering was also evaluated including the physical readiness and attitudinal readiness. The majority of the contractors were physically ready in terms of 'Good Knowledge of Information Technology' and attitudinally ready in terms of 'Computing Infrastructure' and 'Technical and Knowledgeable Staff'. Additionally the majority of the contractors are willing to participate in e-tendering if they are invited. The most important factor contributing to the willingness to participate in e-tendering was 'Improve Business Opportunity' while 'Internet Threats' was the most important factor impeding the willingness.

Keywords: E-tendering, adoption, participation, contractors, Malaysia

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INTRODUCTION

In the past decade, organisations from all over the world have tried to take advantages of information technology (IT) to improve their business processes. IT provides the opportunity for organisations to better deliver its information and services and to interact with business partners in a more efficient and effective way (Wahid, 2010).

The construction industry has entered into new dimensions with the advent of IT. The key success factor is to accept the change and to adopt a new way of working in this traditional and fragmented industry (Blayse and Manley, 2004). Organisations have to adapt to changes in today's borderless economy or risk being eliminated (Alshawi, 2007). Businesses are moving away from traditional processes to modern and efficient ways of working through electronic media. Data and information are shared and distributed electronically, developing a cheaper and more effective way of communication. Electronic processes may generate huge new wealth and change the way business is conducted (Amit and Zott, 2001).

Electronic tendering, also known as e-tendering, has been recognised for some time as being a potential tool to assist in changing the construction industry's culture and improving its processes (Lavelle and Bardon, 2009). E-tendering systems serve as a medium of exchanging data and information electronically during tendering process.

In Malaysia, the e-tendering system was introduced by E-construction under the initiative of the Construction Industry Development Board (CIDB) and the government in 2004 to replace the traditional tendering process. The Public Works Department (PWD) has become a pioneer in implementing tendering by disc where the tenderers are given a digital Bill of Quantities instead of a printed Bill of Quantities. In 2008, CIDB and PWD collaborated to implement the National eTender Initiative (NeTI). This paved the way for the country's entire construction supply chain processes to be automated (PWD, 2008). The system aimed to improve the overall productivity, efficiency and efficacy of the tendering process in the Malaysian construction industry.

This study aims to investigate the potential of Malaysian construction industry organisations to adopt and participate in e-tendering. The objectives of this study were:

- To evaluate the satisfaction of construction organisations with the traditional tendering system.
- To assess the perceived benefits and challenges of e-tendering system.
- To investigate the level of readiness of Malaysian construction industry to adopt e-tendering.
- To investigate the willingness of construction organisations to participate in e-tendering.

LITERATURE REVIEW: GENERAL TENDERING PRACTICES IN MALAYSIA

In Malaysia, all government projects are under the supervision of the Public Works Department (PWD). PWD is the main implementing agency in carrying out development projects throughout the country. Tenderers need to advertise the tender in at least one major daily newspaper in Malay. International tenders should be advertised in at least two newspapers, of which one is Malay and one English-language. Tender advertisements are released on every Monday and Thursday in local newspapers. Interested contractors who meet the registration requirements can purchase the tender documents from PWD headquarters or the state for government project. Tenderers will be given a tendering period of not less than 21 days for local tenders. However, the tendering period is depending on the type of project and type of contract used.

Tenders will be closed on the date and time stated in the advertisement. Tenders are to be opened on the same day as this closing date and the time lapsed must be kept to a minimum i.e. tender closed at 12 noon and tender opened at 2.30p.m. After the tendering period has elapsed, tenders are evaluated. The tender will be awarded to a qualified contractor who provides a competitive price and who is capable of achieving the required quality.

E-TENDERING IN MALAYSIA

Way back in 2004, Construction Industry Development Board (CIDB) had collaborated with Public Works Department (PWD) on a project that is expected to change the tendering process in Malaysian construction industry. CIDB's role under this project is to develop, implement, operate and maintain the National e-Tender System. The aim of National e-Tender System is to improve corporate governance in the public construction tendering process which includes tendering information management, tender distribution and the selection of services for all construction works undertaken by the government (Corporate Viewpoint, 2004).

NATIONAL E-TENDERING INITIATIVE IN MALAYSIA

According to Slide Share (2010), National e-Tendering Initiative (NeTI) is a national initiative that integrates every process of tendering onto an electronic medium in the hope that it can then transcend geographical, time, economical and human error barriers. NeTI also wished to overcome the inefficiency barriers by speeding up the tendering process to benefit all the parties involved in the tendering process.

NeTI is introduced to meet customer demand for higher cost and time efficient tendering process. It main function was to solve biggest e-tendering challenge while achieving profitable growth for IT industry in construction. As an online tendering system, NeTI would supplement the digital regulatory approval process that has already been implemented by the Government for the construction sector. This exercise was in line with the objectives of the Construction Industry Master Plan

2006-2015 through Strategic Thrust 6, which focused on leveraging ICT in the construction industry.

Under this new system, contractors tendering for government projects have to key in their particulars online via the NeTI website. NeTI would evaluate if the contractor was qualified to tender for the project based on his financial position, technical expertise and strength. The contractor would be informed of the reasons for disqualification from tendering for the project and this would increase the transparency level. Through this system the contractor can avoid wasting time and money as well as unnecessary travel in submitting tenders for a project that he cannot secure.

According to Bernama (2011), PWD currently will only receive tenders from up to 50 contractors for every project. It is common that 60% of them are found to be unqualified to tender for the project. Unqualified contractors were informed of the reasons for disqualification so that they can improve themselves. Through this system, contractors will not be constrained by office hours meaning tendering can be carried out at any time regardless of location.

As NeTI is a fully computerised system, certain skill is needed in order for the contractors to manage the system well e.g. correctly enter calculations and data on their bids. A tender price which is extremely low i.e. below 15% cut-off price would be rejected as the contractors would be suspected to have underestimated.

PWD had already carried out 13 trial projects and 2 pilot projects using both the NeTI and normal tendering process to gauge the new system's effectiveness from 2008 till present. Currently, NeTI is only used by the Class A or Grade 7 contractors for government projects worth RM10 million (£2 million approx.) and above to allow contractors of other classes to prepare towards using the system. The implementation will be done stage by stage to cover all categories of projects and involve all categories of contractors. Under the plan, NeTI will be used by Class B contractors and below in five years time.

RESEARCH METHODOLOGY

This research is conducted by questionnaire survey which was distributed to the Malaysian construction industry. A structured questionnaire was used to gather information from the respondents. The respondents consist of Class A to Class D contractors registered under PKK. The respondents were randomly selected from the list of contractors published on PKK website. The questionnaire was self-administered and sent to respondents by post.

The questionnaire consisted of five parts; each part contained questions to serve the intended function to obtain required information. Part A was designed to investigate the profiles of the companies which included the company's PKK registration, years of operation and turnover of the company. The first part is to show the validity of the respondents and reliability of the results collected by sorting the respondents into different groups.

Part B consisted of 3 questions which were in line with Objective 1; to evaluate the satisfaction of construction organisations with the traditional tendering system. The first question requires respondents to answer which tendering practices they prefer, either traditional tendering or e-tendering; while the second question asked the respondents to state whether or not they are satisfied with the traditional tendering system. The third question asked respondents to indicate their level of agreement to the 6 disadvantages of traditional tendering identified. This question is only set for those respondents who are dissatisfied with the traditional tendering system. For those who are satisfied with the traditional tendering system, they do not have to answer this question.

Two questions from Part C were to fulfil the Objective 2 which was to assess the perceived benefits and challenges of the e-tendering system. Questions asked were to find out respondents' opinion regarding the benefits and challenges of e-tendering based on their personal experience. The first question identified 8 e-tender benefits from the literature. The respondents were provided with a list of statements and asked to identify how much they agreed or disagreed with them on a Likert scale of 1 (Strongly Agree) to 5 (Strongly Disagree). The second question addressed 7 challenges of e-tendering and respondents were asked to rank the extent of significant of these challenges to the Malaysian construction industry. The question is also in the form of five-point Likert scale, where "1" represented "Very Significant" and "5" represented "Insignificant".

Part D of the questionnaire focuses on the readiness of respondents to adopt e-tendering. To identify the readiness of the respondents, this survey incorporated both attitudinal readiness and physical readiness. The first question asked was to determine the respondents' attitudinal readiness. 5 variables had been identified which included the level of knowledge, awareness, perception of importance, interest and perception of tendering trends. Respondents were asked to rank their attitudinal readiness from 1 to 5 in the form of Likert scale. The second question was set to identify respondents' physical readiness in terms of personnel, investment in IT and infrastructure readiness. This question also required respondents to rank their readiness in the form of a Likert scale.

Part E of the questionnaire contained the questions which reflect the organisations' willingness to participate in the e-tendering system. The first question asked respondents' opinion whether they would participate in e-tendering if invited. Those respondents who stated they were willing to participate in e-tendering were required to answer the second question while those who were not willing were required to answer the third question. Both the second and the third questions were in the form of five-point Likert scale, where "1" represented "Not Concerned" and "5" represented "Very Concerned". 5 variables has been identified for each question which include clarity and simplicity, low operating cost, time saving, improve company's competitiveness and business opportunity for the 2nd question; low confidentiality, internet threats, high initial capital, lack of in-house skills with relevant knowledge and experience in e-tendering for the 3rd question.

METHOD OF ANALYSIS

The "importance index" method was adopted to ranks the important among these variables/factors. The "importance index" was calculated for each item by using the following formula:

$$\textit{Importance Index} = \frac{\sum \beta \, x \, n}{N}$$

where, β is the weighting given to each factor by the respondents;

n is the frequency of the respondents;

N is the total number of respondents.

DATA ANALYSIS AND RESULTS

Respond rate, company profile and respondents 'details

A total of 100 questionnaires were distributed by post to various contractor companies in Klang Valley. Of 100 questionnaires sent, 37 responses were returned. Contractors registered under Pusat Khidmat Kontraktor (PKK) Class A represent 18 of total responses, Class B – 6, Class C – 7 and Class D – 6. More than half of the respondents' companies (28 of the total 37 responses) have been operating in the construction industry for more than 10 years. Only 1 company had operated for less than 5 years, 8 had operated between 5 to 10 years, 17 had operated between 10 to 20 years while 11 have been in operation for more than 20 years.

The majority of the companies (24 of total response) had an annual turnover of over RM4 million. Only 1 respondent's company had turnover between RM500,000 to RM 900,000in year 2010, 2 had less than RM300,000, RM300,000 to RM499,000 and RM1 million to RM1.9 million respectively, 3 had RM7 million to RM9.9 million and RM15 million to RM20 million respectively, 5 had RM4 million to RM6.9 million, 6 had RM2 million to RM3.9 million and RM10 million to RM14.9 million respectively, followed by the highest turnover which was 7 of companies had more than RM20.0 million turnover. See Table 7.

Contractors	Sent	Received
Class A	30	18
Class B	25	6
Class C	25	7
Class D	20	6
Total	100	37

Table 5 Number of questionnaire received from Class A to Class D contractors

Company Years of Operation	Frequency
0-5years	1
5-10years	8
10-20years	17
>20years	11
Total	37

Table 6 Distribution of company years of operation

Company's Turnover Malaysian Ringgit	Company's Turnover GBP approx.	Frequency
Less than RM 300K	Less than £60,000	2
RM 300K - RM 499K	£60,000-£100,000	2
RM 500K - RM 0.9 Million	£100,000-£180,000	1
RM 1 Million - RM 1.9 Million	£200,000-£380,000	2
RM 2 Million - RM 3.9 Million	£380,000-£800,000	6
RM 4 Million - RM 6.9 Million	£800,000-£1,400,000	5
RM 7 Million - RM 9.9 Million	1,400,000-£1,800,000	3
RM 10 Million - RM 14.9 Million	£1,400,000-£3 million	6
RM 15 Million - RM 20.0 Million	£3 million-£4 million	3
More than RM 20.0 Million	over £4 million	7
Total		37

Table 7 Distribution of company's turnover of year 2010

The majority of the respondents (28 of the respondents) are from the top management levels with Directors representing 7 of the total response, Project Managers – 8, Contract Managers – 6, General Managers – 7, Quantity Surveyors – 2, Site supervisor – 1, Project Coordinator – 1, Assistance Contract Manager – 1, Admin Executives – 2 and Admin Clerk – 2.

Thus, majority of the respondents are familiar with the tendering procedures and processes in Malaysia. It is also understood that they have good experience in the Malaysian construction industry. Hence, responses obtained can be relied upon with confidence.

Company's Position	Frequency
Director	7
Project manager	8
Contract manager	6
General manager	7
Quantity surveyor	2
Site supervisor	1
Project coordinator	1
Asst. Contract manager	1
Admin executive	2
Admin clerk	2
Total	37

Table 8 Distribution of respondents' company positions

SATISFACTION OF TRADITIONAL TENDERING

This part evaluates the satisfaction of the construction organisations with the traditional tendering system. It consisted of 3 questions.

Tendering practices preferred

The first question asked was the type of tendering practices respondents prefer. 24 out of 37 respondents preferred traditional tendering system, the remaining 13 respondents prefer e-tendering.

Tender Practices	Frequency
E-tendering	13
Traditional/paper-based	24
Total	37

Table 5 Distribution of tendering practices preferred

Satisfaction of traditional tendering method

Satisfaction	Frequency
Yes	23
No	14
Total	37

Table 5 Distribution of respondents' satisfaction with traditional tendering method

Table 5 shows the satisfaction of respondents with the traditional tendering system. 23 of the respondents were satisfied with the current traditional method while 14 of the respondents are dissatisfied. The satisfaction of respondents may be because of resistance to change. Traditional tendering method has been practiced in the

construction industry for many years and most construction companies are familiar with the traditional methods. Thus, they refuse to use a tendering method which they are not familiar with.

Factors contribute dissatisfaction of traditional tendering

Variables	N	Mean	Important Index	Rank
Little storage capacity	14	3.64	72.9%	5
Lack of security	14	3.64	72.9%	5
Time wastage	14	4.21	84.3%	3
High cost	14	4.07	81.4%	4
Labour intensive task	14	4.36	87.1%	2
Intensive administration tasks	14	4.36	87.2%	1

Table 6 Factors contribute of dissatisfaction of traditional tendering

This question was set for those respondents who were dissatisfied with the traditional tendering. It was to identify the dissatisfaction of respondents with the traditional tendering system. According to Table 6, majority of the respondents ranked the three most severe disadvantages of traditional tendering as ‘labour intensive tasks’, ‘intensive administrative tasks’ and ‘time wastage’. Labour intensive and administrative come in the form of an increase in workload and reduced efficiencies. Most companies nowadays seek administrative efficiencies in tendering methods. Traditional tendering involves intensive secretarial and administrative tasks were the main source of dissatisfaction from the companies on traditional tendering. Contractors needed to get tender and contract information and documentation from the client and this reflected in their choice of time wastage as one of the three most severe disadvantages.

Higher cost of traditional tendering method was less important to respondents as to them; the cost involved in tendering is insignificant when compared to the contract value. Storage capacity to store documents and safety of stored tender documents was perceived as the least severe problems.

BENEFITS AND CHALLENGES OF E-TENDERING SYSTEM

E-tender benefits

Variables	N	Mean	Important Index	Rank
Time saving	37	3.81	76%	3
Reduction in overhead cost	37	4.00	80%	1
Saving in storage space	37	3.92	78%	2
Overcome geographical limitation	37	3.92	78%	2
Increase transparency and fairness	37	3.35	67%	6
Reduce potential for disputes	37	3.32	66%	7
Reduce levels of tender administration	37	3.70	74%	4
Ease of use	37	3.57	71%	5

Table 7 E-tender benefits

This question was to identify the benefits of e-tendering. According to Table 7, cost and storage space were considered to be the most important advantages associated with e-tendering. However, these results are partially in contrast with Lavelle and Bardon (2009) stated that the two most important e-tender benefits are time and cost. Cost is confirmed to be one of the most important factors as shown in this research paper and the results from Lavalle and Bardon. Most of the companies believed that with the use of e-tendering, overhead costs which include cost of printing, copying, paper, postage, and stationery can be greatly reduced.

Lavelle and Bardon (2009) emphasized ‘time saving’ as the most important benefit because of no time constraint by working hours. The contractor is able to download data and documents directly from the website anytime, thus reducing the overall time spent on the tendering process. However, in this research paper, ‘time saving’ is ranked as fourth important which is found to be a less favourable benefit compared to storage space. Respondents think that saving in storage space is more important as most of the companies have operated for many years, been involved in many projects, and thus lack storage space to accommodate those documents. However, with the use of e-tendering, this problem can be overcome.

The third preference of e-tender benefit was it can overcome geographical limitations. The travel time can be eliminated with the use of e-tendering. Tenderers do not have to travel far distance to collect or submit the tender documents, thus overcoming the geographical problem. Other benefits like increased transparency and fairness, reduced potential for disputes, reduced levels of tender administration and ease of use have been ranked as less significant benefits.

E-TENDER CHALLENGES

Variables	N	Mean	Important Index	Rank
Legal issues	37	3.05	61%	4
Hard to share information	37	3.00	60%	5
Security concerns	37	3.27	65%	2
Poor reliability	37	3.30	66%	1
Resistance to change	37	3.24	65%	3

Table 8 E-tender challenges

This question was to find out the challenges of e-tendering. From Table 8, the most important challenge identified was 'poor reliability'. The result is different from that emphasized by Julia-Barcelo (1999) who stated that 'legal issues' was the main challenge of e-tendering. This was because there were concerns about the forgery of signatures, illegal trading or fraud which could happen during electronic transactions. However, in this research, legal issues were found to be only moderately important. The respondents are more concerned about the reliability of the system. Most companies were looking for a reliable system which would be available all the time particularly during tender submission stage. Unavailability of system or system breakdown may cause tenderers to fail to submit their tender.

'Security concerns' and 'resistance to change' were ranked as the second and third most important respectively with little difference in importance between these two. Security threats like hacking or virus attacks have impacts to the system and affect the confidentiality of the data. This is significant as the tenderers do not want their data, especially tender prices, to be known by their opponents.

Another important challenge of e-tendering is 'resistance to change'. Traditional tendering has been practised in the construction industry for so many years. The introduction of e-tendering may change the company's ways of working. Most companies are reluctant to change to avoid deficiencies or disorganisation.

'Hard to share information' and 'high running and maintenance cost' were less important and were ranked as fifth and sixth respectively.

READINESS TO ADOPT E-TENDERING

Attitudinal readiness

Variables	N	Mean	Important Index	Rank
Good knowledge of Information Technology (IT)	37	4.03	80.5%	1
Aware of the introduction of e-tendering by the Government	37	3.68	73.5%	4
Foresee the increasingly importance of e-tendering to company	37	3.78	75.7%	2
Foresee the construction tendering practices trends	37	3.70	74.1%	3
Interested in e-tendering	37	3.70	74.1%	3

Table 9 Company's attitudinal readiness

Physical readiness

Variables	N	Mean	Important Index	Rank
Network access	37	3.89	77.84%	2
Computing infrastructure	37	4.00	80.00%	1
Technical staff / Knowledgeable staff	37	4.00	80.00%	1
Investment in Information Technology (IT)	37	3.89	77.84%	2
Software facilities	37	3.81	76.22%	3

Table 10 Company's physical readiness

The above two questions were to evaluate the attitudinal and physical readiness of the companies to adopt e-tendering. There were 5 variables for each question.

The measurement of readiness of the respondents was carried out based on the overall mean score. Various factors have been identified as critical factors which influence the attitudinal readiness of the companies. The factors identified were the level of knowledge, awareness, interest, perception of importance and perception of tendering practices trend. From Table 9, level of knowledge has been determined as the strongest contributory factor towards the attitudinal readiness. It was also noted that awareness solely, will not contribute towards the level of readiness of the contractors.

The technical information comprised evaluation of the availability of network access, hardware, technical staff, information technology and software facilities. Table 10 shows that the survey found that most of the companies were physically ready to adopt e-tendering, with adequate computer infrastructure and technical or

knowledgeable staff. The absence of software facilities is the major setback of physical readiness. Companies invested in ICT and network access moderately.

From the results, it can be concluded that e-tendering is ready to play a major part in the activities of the Malaysian construction industry from the contractors' point of view. The result from this study however, is in contrast with the Alias and Yusuf (2007). Their findings state that the Malaysian construction industry is not ready to adopt e-tendering neither attitudinally nor physically. In their research paper, the major setback of attitudinal readiness was the perception of importance of e-tendering. This is because e-tendering is still a relatively new concept at the time research was conducted, thus most of the construction organisations believed that e-tendering was not important. However, due to the advancement and gradually realising the importance of Information Technology, construction organisations started to realise the importance of e-tendering. This is the reason why the result of this study was different from that of Alias and Yusuf (2007). For physical readiness, lack of internet access was identified as the stumbling block in their study. Advancement of technology is again the main reason that contrast occurs.

WILLINGNESS TO PARTICIPATE IN E-TENDERING

Willingness to adopt in e-tendering

Willingness	Frequency
Yes	32
No	5
Total	37

Table 11Willingness to participate in e-tendering

Respondents were asked to indicate the extent to which their companies are willing to participate in e-tendering. The results show that, generally construction companies were highly willing to participate in the e-tendering system. 32 respondents were willing to participate in e-tendering if they were invited while 5 respondents were unwilling.

Factors contribute to willingness to participate in e-tendering

Factors	N	Mean	Important Index	Rank
Clarity and simplicity of e-tendering system	32	3.47	69.4%	4
Low operating cost	32	3.31	66.3%	5
Time saving	32	3.59	71.9%	2
Improve company's competitiveness	32	3.56	71.3%	3
Improve business opportunity	32	3.69	73.8%	1

Table 12 Factors Contribute to Willingness to Participate in E-tendering

This question was to evaluate the factors that contributed to the willingness of companies to adopt and participate in e-tendering system. 5 variables were identified from the literature. The results were computed and presented in Table 12.

The results show that 'improve business opportunity' is likely to have the highest influence on the companies' willingness to participate in e-tendering. Electronic processes have the potential to generate huge new wealth and to transform the way business is conducted in unprecedented ways. The continuing expansion of using electronic means in the business will provide opportunities for improved business processes.

71.9% of the respondents stated they were willing to participate in e-tendering because of the time saving factor. E-tendering systems which automate all tendering processes enable contractors to have easily access to the system to obtain the desired information. With this system the overall time spent can actually be reduced; this reflects their choice of time saving as one of the three most important factors.

'Improve company's competitiveness' was ranked as the third concern by the respondents. With the use of e-tendering, companies can actually improve their competitiveness. This is because the construction industry in Malaysia is moving away from traditional processes to modern and efficient ways of working, through electronic media. Thus, e-tendering is actually standing at the bright side and is more competitive when compared to traditional tendering.

'Clarity and simplicity of tendering system' and 'low operating cost' have been ranked as less concerning factors affecting the willingness of participation in e-tendering.

Factors contribute to unwillingness to participate in e-tendering

Factors	N	Mean	Important Index	Rank
Low confidentiality	8	3.25	65.0%	4
Internet threats	8	3.75	75.0%	1
High initial capital	8	3.25	65.0%	4
Lack of in-house skills with relevant knowledge	8	3.50	70.0%	2
Lack of experience in e-tendering	8	3.38	67.5%	3

Table 13 Factors Contribute to Unwillingness to Participate in E-tendering

This question was to evaluate the factors that contribute to the unwillingness of companies to adopt and participate in e-tendering systems. The results are computed and presented in the Table 13.

The results show that 'internet threats' was likely to have highest influence on the companies' unwillingness to participate in e-tendering. This result suggests that security is an important concern that could influence participation in e-tendering. Internet threats represent computer virus attacks that can severely harm the system. It could also affect confidentiality of e-tendering.

The second important factor was 'lack of in-house skills with relevant knowledge'. Though some of the companies may have prepared themselves to involve in e-tendering, (equipped themselves with the technology), if the company staff has no relevant knowledge on it, it becomes impractical to practice the e-tendering.

The third important factor is 'lack of experience in e-tendering', followed by 'high initial capital' and 'low confidentiality'. The construction industry has been involved in traditional tendering for the past decades. Most of the construction companies are very experience in this tendering method. E-tendering, on the other hand, is still at its infant stage. Companies have little or no experience in e-tendering. This contributes to their unwillingness to participate in e-tendering.

Companies are not so concerned about the high initial cost. So long as e-tendering can help the companies to save running cost, they would like to go for it. In addition the respondents of this research are from large or medium size companies and are financially capable. Therefore, initial capital involved in implementation of e-tendering is insignificant to them.

'Low confidentiality' is also not significant from the companies' perspective. With the use of e-tendering, passwords will be used to control the accessibility of the tender file. Other staff from the company may not be able to access the data, thus keeping the tender data confidential.

CONCLUSIONS

The first objective of this research was to evaluate the satisfaction of construction organisations with traditional tendering system. The results obtained from the questionnaire analysis shows that majority of the contractors (24 out of 37 respondents) are satisfied with traditional tendering system. The underlying reason was reluctance to change. Traditional tendering has been practised in the construction industry for decades, most of the contractors are familiar with this type of tendering practice, thus they refuse to change to e-tendering which they are not familiar with. The minority of contractors are dissatisfied mainly due to the labour intensity of traditional tendering.

The second objective was to identify the perceived benefits and challenges of e-tendering. The three most important benefits of e-tendering were 'Reduction in overhead cost', 'Saving in storage space' and 'Overcome geographical limitation' while the three greatest e-tender challenges are 'Poor reliability', 'Security concerns' and 'Resistance to change'.

The third objective was to investigate the level of readiness to adopt e-tendering in the Malaysian construction industry. This research reflects that the Malaysian construction industry is most ready attitudinally in terms of 'Good Knowledge of Information Technology (IT) and most physically ready in term of 'Computing Infrastructure' and 'Technical Staff and Knowledgeable Staff'' to adopt e-tendering.

The last objective was to identify willingness of organisations to participate in e-tendering. The majority of the contractors were willing to participate in e-tendering if they were invited. 'Improve business opportunity' has been identified as the most significant factor contributing to their willingness. On the other hand, 'Internet threats' was the most significant factor impeding their willingness.

The findings of this research are only applicable in the Malaysian construction industry. This research was conducted within construction companies located in Klang Valley thus the results obtained do not necessarily represent the opinions of all construction companies in Malaysia.

The responses are only focused on contractors. Other parties in the construction industry e.g. developers, consultants, sub-contractors etc. were not involved in this research. The technical issues of the e-tendering system itself including the security and legal issues were not studied in detail due to the limitations of the study. Technical issues would affect the reliability of the system, which in turn would affect the willingness of contractors to participate in e-tendering.

This research also does not study the people issue in detail which can be one of the critical success factors to successfully implement e-tendering in the construction industry.

As this study is being conducted in Klang Valley only, more extensive research in Malaysia is recommended to obtain more accurate findings. This should be extended to other construction stakeholders e.g. developer, consultants, sub-contractor and etc.

as these are the parties who may also need to be involved in e-tendering. Research should be carried out to find out their willingness to participate in e-tendering.

An in-depth study on technical issues of e-tendering systems is also recommended to find out how these factors affect the willingness of contractors to participate in e-tendering.

Further, as people issue could be a stumbling block of e-tendering participation, further study should also be carried out to investigate the impact of these upon e-tendering participation in the Malaysian construction industry.

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SICK BUILDING SYNDROME IN LECTURE HALLS OF A HIGHER EDUCATION INSTITUTION

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ABSTRACT

This paper investigates sick building syndrome (SBS) in the lecture halls of a local higher education institution. Questionnaires were used in a cross-sectional survey to obtain the possible causes of SBS and its effect on the health and comfort of students who regularly use the halls for lecture purpose. Students' satisfaction with the lecture halls' indoor environment was also measured, as well as their concerns on the improvements needed. Finally, the relationship between students' overall satisfaction and the lecture halls' indoor environment was investigated through regression analysis.

Keywords: Sick building syndrome, causes, effects, students' satisfaction, indoor environment, concerns for improvement

INTRODUCTION

Sick building syndrome (SBS) is used to describe a situation in a building where the occupants experience a range of symptoms causing discomfort and a feeling of being unwell. It started with the introduction of energy conservation measures following the oil crises in the early 1970s (Singh, 1996; Syazwan Aizat et al., 2009), where office buildings were constructed to be 'air-tight' architecturally by sealing up the building to reduce ventilation rate in order to save energy consumption. As a result, health care providers were faced with an increasing numbers of people having headaches and allergic-like reactions to undetermined stimuli (Heimlich, 2008). A well-known

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example of SBS is Legionnaires' disease, first reported in 1976, and it was subsequently attributed to a previously unknown strain of bacteria, named Legionella.

According to Babatsikou (2011), SBS may also happen in communal buildings such as hospitals, educational institutions and apartment buildings, although it seems to occur only in buildings with automated heating, ventilation, air conditioning (HVAC) systems. The indoor air as well as the temperature, light and sound conditions in dwellings, offices, schools and other premises is of utmost importance to the health, comfort, morale, productivity and well-being of the occupants (Singh, 1996). A case of SBS was reported in a residential home in Kuala Lumpur where the family was diagnosed as suffering from sore throat and nose irritation due to formaldehyde (The Sun, 2010). Of late, SBS has also become a common issue in Malaysia due to the construction of buildings designed to be more energy-efficient with air-conditioning systems but poor maintenance and services of HVAC systems, resulting in an increase of indoor air pollutants (IAPs) level (Syazwan Aizat et al., 2009). As students spend a large proportion of their time daily at colleges/universities, there is thus a need to study SBS at places such as lecture halls or the library, which are also architecturally sealed and provided with air-conditioning systems. Therefore, the objectives of this paper are to: (a) identify the causes of sick building syndrome (SBS) in lecture halls of a local higher education institution (HEI); (b) determine the effects of SBS towards students using these lecture halls; (c) assess students' satisfaction with the indoor environment of these lecture halls; (d) investigate the relationship between students' overall satisfaction with these lecture halls' indoor environment; and (e) assess their concerns for the improvements needed for these lecture halls.

LITERATURE REVIEW

A study by Syazwan Aizat *et al*. (2009) showed that there was significant association between ventilation rate and the prevalence of SBS. Their study involved two buildings, and the building with the lower ventilation rate showed a higher prevalence of SBS. The building with a lower ventilation rate, which was constructed earlier, had higher IAPs such as carbon dioxide (CO_2), carbon monoxide, total volatile organic compound, and particulate matters such as PM_{10} and $PM_{2.5}$. They found that the newer building had a higher concentration of ultrafine particles and temperature humidity index (THI) value. The level of THI and CO_2 was found to be the major factors contributing to SBS complaints among the 176 office workers working in these two buildings who participated in their study.

The quality of a building's indoor environment reflects on the health, comfort and productivity of individuals in the building (Singh, 1996). The main causes of SBS have been identified due to: (a) inadequate ventilation/poor indoor air quality; (b) the presence of volatile organic compounds; (c) internal sources of pollution; (d) external sources of pollution; (e) unconducive indoor temperature and humidity; (f) excessive background noise; (g) poor or inadequate lighting; and (h) psychosocial factors (Pasarelli,2009).

Symptoms which have been established to be associated with SBS include eye and nose irritations, dry skin, headaches, coughs, dizziness, inability to concentrate, and exhaustion after normal activity (Morris and Dennison, 1995). According to Rostron (2008), these symptoms can be divided into five categories as given in Table 1: (a) mucus membrane irritations which affect the eyes, nose and throat; (b) neuropsychiatric disturbances such as fatigue, headache, confusion and dizziness; (c) skin disorders such as itchiness, dryness and rashes; (d) asthma-like symptoms such as tight chest and difficulties in breathing; and (e) unpleasant odour and taste sensations.

Sick Building Symptoms	Examples
Eye, nose and throat irritations	- Dryness, - Stinging, smarting, irritating sensation, and - Hoarseness, changed voice.
Sensation of dry mucous membranes and skin	- Reddening of skin, - Stinging, smarting, irritating sensation, - Dry skin, and - Erythema (skin rash).
Neurotoxic symptoms	- Mental fatigue, - Reduced memory, - Lethargy, tiredness, drowsiness, - Difficulty in concentrating, thus memory reduced, - Headache, high frequency of airway infections and cough; - Dizziness, intoxication, and - Sickness.
Unspecified hyperactions	- Runny nose and eyes, - Asthma-like symptoms in non-asthmatic persons, and - Respiratory sounds.
Odour and taste complaints	- Changed sensitivity, and - Unpleasant odour or taste.

Table 1: Symptoms of Sick Building Syndrome (Source: Molhave, 1987; cited by Rostron, 2008, p. 292)

According to Curwell, March and Venables (1990; cited by Singh, 1996, p. 125), the quality of the built environment is associated with the health, comfort and productivity of building occupants. They mentioned that perception of an unpleasant odour is a discomfort effect, where discomfort can be defined as that condition of mind which expresses dissatisfaction with the environment; and irritation is usually defined as an acute health effect. According to Rostron (2008), SBS can have serious implications, such as reduced productivity, reduced overtime, increased staff turnover, increased sickness which results in absenteeism. Leaman (1995; cited by Haynes,

2008) claimed that for office workers who were dissatisfied with the temperature, air quality, lighting and noise conditions in their offices, productivity at work would be affected. Hansen (1995) opined that SBS would increase absenteeism from work when the workers felt sick and made appointments with doctors for allergy treatments and unspecified sickness due to indoor air quality (IAQ). As a result their productivity was affected and their morale reduced. In addition, employers' had to finance extra medical care costs.

To reduce the frequency and severity of SBS symptoms, the following preventive measures could be taken (Rostron, 1997): (a) increase ventilation rates, where a minimum fresh air flow of 8 litres per second per person is recommended; (b) improve IAQ, where the air is free from hazardous chemical or microbiological contaminants; (c) appropriate temperature and humidity; (d) reduce background noise; and (e) provide sufficient lighting. In addition, Babatsikou (2011) suggested structural repairs of building to prevent leaks and humidity, removal or modification of the pollutant source, a review of chemicals used in buildings, such as non-toxic building materials for walls, floors and ceilings.

RESEARCH METHODOLOGY

Singh (1996) advised the use of questionnaires to identify and assess building related health problems. The questionnaire should aim to cover the various aspects of building design and construction, services and controls, occupancy, use of the building and the building environment. It should attempt to find out the causes and effects of the building related problems, covering a range of symptoms experienced by the occupants. For their study on SBS symptoms, Syazwan Aizat *et al*. (2009) based their questions on the Indoor Air Quality and Works Symptoms Survey of NIOSH (National Institute Occupational Safety and Health) Indoor Environmental Quality Survey (1991).

For this study, a set of questionnaires were prepared to collect the raw data. The questionnaire is divided into five sections:

a) Part A collects general information from the respondents;
b) Part B explains the symptoms experienced by the respondents;
c) Part C elicits the possible causes of SBS in the lecture halls from the respondents;
d) Part D requests the respondents to indicate their satisfaction with the lecture halls' indoor environment on a 5-point Likert scale (from very dissatisfied to very satisfied); and
e) Part E requests the respondents to express their concerns of improvements needed for the lecture halls on a 5-point Likert scale (from not concerned at all to the most concerned).

The questionnaire was designed based on information obtained from the literature review, as well as after three rounds of consultations with the supervisor. Therefore, it has good content validity as content validity can only be determined by experts and by reference to the literature (Han, 2000). Content validity is a judgement by experts of

the extent to which a scale truly measures the concept that it is intended to measure based on the content of the items.

The reliability of the questionnaire was assessed with the data collected. Reliability of a questionnaire refers to the consistency of a measurement, namely the extent to which the measurement can produce similar results in measuring people under similar conditions. The most widely and commonly used method for assessing the reliability of a measurement scale with multi-point items is Cronbach's Coefficient Alpha. According to Kline (1998), reliability coefficients around 0.90 can be considered as excellent, values around 0.80 as very good, values around 0.70 as adequate, and those below 0.50 should be avoided.

The questionnaire was used in a cross-sectional survey conducted from 17th to 24th October 2011. The term SBS was explained before a total of 100 questionnaires were distributed to a convenience sample of 226 students taking two different programmes in the local HEI. These students were seniors and they have studied in the HEI for more than three years. The HEI was set up in the 1960s, and one of the lecture halls (LH A) was constructed in 1990.

DATA ANALYSIS AND RESULTS

Out of the 100 questionnaires administered to the students, 88 completed questionnaires were received. 51 of the students were male and 37 were female. 39 students mentioned that they heard of SBS before, whereas 49 students mentioned that they had not heard of SBS. 42 students were of the opinion that the lecture halls in the HEI were affected by SBS, whereas 46 indicated negative. When the students were asked if they felt unwell when they were in the lecture halls, 35 students answered yes, but 51 students answered no, and 2 abstained. These results are shown in Table 2. 65 students mentioned that they spent up to 6 to 12 hours per week in the lecture halls. When they were asked to indicate the lecture hall (LH) they spent the most often, 55 (62.5%) students indicated LH W, whereas 43 (48.9%) students indicated LH A.

Dichotomous questions	Replied 'Yes'		Replied 'No'	
	Frequency	Percentage	Frequency	Percentage
Heard about SBS?	39	44.3	49	55.7
Is SBS injurious to health?	58	65.9	30	34.1
Are the lecture halls affected by SBS?	42	47.7	46	52.3
Feeling unwell in the lecture halls?	35*	40.7	51*	59.3

*Table 2: General information from the respondents * 2 students did not reply for this item.*

Table 3 gives the responses of the students on the symptoms experienced while in the lecture halls. More than 60% of the students felt tired and had difficulty in

concentrating, whereas 36.4% experienced stress. Less than 10% of the students experienced stuffiness and coughing when attending lectures in the hall.

Symptoms experienced while in the lecture halls	Frequency (N = 88)	Percentage	Ranking based on percentage
Tiredness	68	77.3	1
Difficulty in concentrating	53	60.2	2
Stress	32	36.4	3
Eyestrain	29	33.0	4
Headaches	27	30.7	5
Dry skin	23	26.1	6
Difficulty in breathing	23	26.1	6
Flu	11	12.5	7
Lethargy	10	11.4	8
Stuffiness	7	8.0	9
Coughing	7	8.0	9

Table 3: Symptoms experienced while in the lecture halls

Table 4 gives the responses of the students on the factors affecting comfort while in the lecture halls. More than 50% of the students identified inadequate ventilation, cleanliness and air freshness affecting their comfort in the lecture halls. They also identified high temperature, maintenance issues, inadequate lighting and excessive background noise as the other main factors affecting comfort.

Items affecting comfort while in the lecture hall	Frequency (N = 88)	Percentage	Ranking based on percentage
Inadequate ventilation	51	58.0	1
Cleanliness of the lecture hall	50	56.8	2
Air freshness (odour)	47	53.4	3
High temperature	43	48.9	4
Maintenance issues	41	46.6	5
Inadequate lighting	40	45.5	6
Excessive background noise	38	43.2	7
Humidity	26	29.6	8
Air pollutant	23	26.1	9
Design of the building	14	15.9	10
Human factors (age, gender, etc.)	12	13.6	11
Use of building	7	8.0	12

Table 4: Factors affecting comfort

Table 5a shows the students' satisfaction with the lecture hall. The results show that students were generally dissatisfied with the noise from microphone, workspace setup, cleanliness of lecture halls, visual display unit, population of students in the lecture hall, air quality and air temperature. The students' overall satisfaction with the lecture halls was just slightly below neutral (2.94). The reliability of the questionnaire items on satisfaction was very good, as given by the Cronbach's Alpha value of 0.807 in Table 5b. Cronbach's α measures reliability of a scale based on a single administration of a measure. In this paper, the questionnaires were administered in a cross-sectional survey to investigate the relationship between students' overall satisfaction with the lecture halls' indoor environment, as exemplified by the first 11 item in Table 5a. According to Yockey (2011), Cronbach's α is "mathematically equivalent to the mean of all the possible splits that could have taken of the measure" to calculate this value. Ideally the Cronbach's α of a scale should be above 0.7 (DeVellis, 2003, cited in Pallant, 2007:95). For the purpose of saving space, the last column in Table 5a reports the "Cronbach's Alpha if item is deleted". Comparing these values with the final value of .807 in Table 5b, the impact of removing each item from the scale can be inferred. If any of the values in this column are higher than the final alpha value, removal of the item from the scale could be considered (Pallant,

2007). Based on this argument, it is not advisable to remove any of the 12 items from Table 5a.

Satisfaction with the following items of the lecture halls	Variable name	Mean value*	Standard deviation	Cronbach's Alpha if Item is Deleted
Noise from microphone	SatQ9	2.36	0.912	0.795
Workspace Comfort (table & chair setup)	SatQ4	2.52	0.871	0.805
Cleanliness of the Lecture Hall	SatQ10	2.58	0.827	0.811
Visual display units	SatQ5	2.67	0.880	0.792
Density of students' population in the Hall	SatQ11	2.74	0.851	0.790
Air quality (air freshness)	SatQ3	2.84	0.801	0.773
Air temperature	SatQ1	2.86	0.847	0.799
Ventilation comfort	SatQ2	3.05	0.801	0.779
Lighting (How bright the lightings are)	SatQ6	3.17	0.698	0.798
Noise from air-conditioning system	SatQ7	3.23	0.919	0.796
Noise from lighting system	SatQ8	3.39	0.877	0.795
Overall Satisfaction	OverallSat	2.94	0.717	0.778
*Note: 1 = Very dissatisfied; 2 = Dissatisfied; 3 = Neutral; 4 = Satisfied; 5 = Very satisfied				

Table 5a: Satisfaction with lecture halls

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.807	.811	12

Table 5b: Reliability Statistics of 12 items on satisfaction

Regression analysis was conducted to check the relationship between students' overall satisfaction with the lecture halls' indoor environment as exemplified by first 11 items in Table 5a. The results are shown in Figure 1a and Figure 1b. Model 1 in column 1 of Figure 1b shows that all the 11 predictors have no significant relationship with overall satisfaction, as exemplified by the *p*-values ≥ .05. Except for SATQ6, i.e. lighting, the remaining 10 predictors have positive but non-significant impact on overall satisfaction.

To identify predictors which have significant relationship with overall satisfaction, a few methods are available in SPSS. In the paper, the authors chose the "backward" method in order to give the highest R^2 value as found in column 3 of Figure 1a. From the *p*-values (≤ .05) for Model 8 in Figure 1b, there are four predictors with positive significant relationship with overall satisfaction. From the outputs shown in Figure 1a and Figure 1b, the relationship between students' overall satisfaction and the lecture halls' indoor environment is: OverallSat = 0.682 + 0.270*SatQ3 + 0.168*SatQ5 + 0.167*SatQ10 + 0.224*SatQ11. These four items explain 44.2% of the variability in students' satisfaction with the lecture halls' indoor environment (Field, 2009).

Table 6a shows the students' concerns of the improvement needed for the lecture halls. The results show that students were generally concerned with all the items mentioned, especially cleanliness of the lecture halls and proper air ventilation. The reliability of the questionnaire items was very good, as given by the Cronbach's Alpha value of 0.825 in Table 6b.

Improvements needed for the lecture halls	Variable name	Concern for improvement			Cronbach's Alpha if Item is Deleted
		Mean value*	Standard deviation	Ranking based on mean value	
Cleanliness of the lecture hall	ImpQ5	3.97	0.794	1	0.820
Proper air ventilation	ImpQ6	3.91	0.930	2	0.803
Better work space environment	ImpQ4	3.84	0.815	3	0.806
Better sound insulation	ImpQ3	3.83	0.950	4	0.808
Better visual display units	ImpQ8	3.82	0.917	5	0.813
Air-con maintenance	ImpQ1	3.81	1.015	6	0.797
Proper lighting design	ImpQ2	3.77	0.906	7	0.794
Better thermal conditions	ImpQ7	3.65	0.935	8	0.803
Floor conditions of the Lecture Hall	ImpQ9	3.56	0.895	9	0.819
*Note: 1 = Not concerned at all; 2 = Least concerned; 3 = Neutral; 4 = Concerned; 5 = Most concerned					

Table 6a: Improvement needed for the lecture halls

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.825	.824	9

Table 6b: Reliability Statistics of 9 items on improvement needed

CONCLUSIONS

So far, no cases of student in the HEI have ever been reported to suffer from SBS. From Table 2, however, it seems that the lecture halls were slightly affected by SBS.

The small percentages of students suffering from SBS symptoms in Table 3 such as headaches, dry skin, difficulty in breathing, flu, lethargy, stuffiness and coughing seemed to support this finding. The main causes of discomfort for the students in the lecture halls were found to be inadequate ventilation, cleanliness of the lecture halls, air freshness, high temperature, maintenance issues, inadequate lighting and excessive background noise (Table 4). The students' overall satisfaction with the lecture hall was just below neutral (2.94), and the main issues causing dissatisfaction were noise from microphone, workspace discomfort, cleanliness of the halls, visual display units, density of students' population in the hall, air quality and air temperature (Table 5a). The main causes of discomfort for the students in the halls seemed to support the main issues causing students' dissatisfaction with the lecture halls. Outputs from regression analysis Figure 1a and Figure 1b showed that air quality (SatQ3), visual display units (SatQ5), cleanliness of the lecture halls (SatQ10), and density of students' population in the hall (SatQ11) significantly affected students' satisfaction.

The students generally indicated their concerns of the improvements needed for the lecture halls. Improvement on the cleanliness of the lecture halls was ranked first by the students. This issue was ranked second by the students which affected their comfort in the lecture halls. This issue was ranked third by the students as causing dissatisfaction. Proper air ventilation was ranked second for improvement. This item was ranked first by the students which affected their comfort, even though they indicated this item as slightly above neutral (3.05) towards their satisfaction.

Based on the findings from this study, the management of the HEI concerned could take proactive measures to improve on the issues highlighted by the students as causing discomfort and dissatisfaction. The management could use the results as a baseline for improvements to be made and benchmark for future study. There is a need to implement the improvements indicated as this could improve students' learning experience in the HEI. Further study could be carried out to determine if the students' satisfaction has deteriorated if no improvements were carried out. Besides, the questionnaire could also be modified or adapted so that similar studies could be done on 'architecturally-sealed' buildings such as libraries and enclosed spaces such as cinemas. One limitation of this study was that the questionnaire was not designed based on the questionnaire for building occupants in the Industrial Code of Practice on Indoor Air Quality 2010. Another drawback, due to time constraint, was that pre-test for the questionnaire was not conducted before the main survey was carried out.

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Figure 1a Model Summary for Regression Analysis (Backward method)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.693[a]	.480	.405	.553
2	.693[b]	.480	.413	.550
3	.692[c]	.479	.418	.547
4	.690[d]	.476	.423	.545
5	.687[e]	.472	.426	.543
6	.683[f]	.466	.427	.543
7	.674[g]	.454	.421	.546
8	.665[h]	.442	.415	.548

a. Predictors: (Constant), SATQ11, SATQ8, SATQ10, SATQ9, SATQ1, SATQ6, SATQ5, SATQ3, SATQ4, SATQ7, SATQ2

b. Predictors: (Constant), SATQ11, SATQ8, SATQ10, SATQ9, SATQ1, SATQ6, SATQ5, SATQ3, SATQ4, SATQ7

c. Predictors: (Constant), SATQ11, SATQ8, SATQ10, SATQ9, SATQ1, SATQ6, SATQ5, SATQ3, SATQ4

d. Predictors: (Constant), SATQ11, SATQ8, SATQ10, SATQ1, SATQ6, SATQ5, SATQ3, SATQ4

e. Predictors: (Constant), SATQ11, SATQ8, SATQ10, SATQ1, SATQ5, SATQ3, SATQ4

f. Predictors: (Constant), SATQ11, SATQ10, SATQ1, SATQ5, SATQ3, SATQ4

g. Predictors: (Constant), SATQ11, SATQ10, SATQ1, SATQ5, SATQ3

h. Predictors: (Constant), SATQ11, SATQ10, SATQ5, SATQ3

Figure 1b Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.388	.399		.971	.334
	SATQ1	.092	.091	.109	1.005	.318
	SATQ2	.002	.126	.002	.015	.988
	SATQ3	.210	.123	.235	1.713	.091
	SATQ4	.140	.094	.170	1.489	.141
	SATQ5	.146	.090	.179	1.622	.109
	SATQ6	-.078	.103	-.076	-.761	.449
	SATQ7	.045	.096	.057	.464	.644
	SATQ8	.060	.099	.073	.604	.548
	SATQ9	.038	.076	.049	.505	.615
	SATQ10	.114	.083	.131	1.368	.175
	SATQ11	.170	.086	.202	1.972	.052
Model 2 to Model 6		Deleted due to space constraint				
7	(Constant)	.490	.324		1.514	.134
	SATQ1	.098	.073	.116	1.345	.182
	SATQ3	.237	.088	.265	2.697	.008
	SATQ5	.175	.080	.215	2.193	.031
	SATQ10	.173	.074	.199	2.339	.022
	SATQ11	.213	.079	.253	2.704	.008
8	(Constant)	.682	.292		2.340	.022
	SATQ3	.270	.085	.302	3.184	.002
	SATQ5	.168	.080	.206	2.096	.039
	SATQ10	.167	.074	.192	2.252	.027
	SATQ11	.224	.079	.266	2.845	.006

a. Dependent Variable: OverallSat

AN OVERVIEW OF THE COLLABORATIVE PARTNERSHIP BETWEEN SHEFFIELD HALLAM UNIVERSITY AND TUNKU ABDUL RAHMAN COLLEGE

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ABSTRACT

This paper provides an outline of the strategic partnership between Tunku Abdul Rahman College and Sheffield Hallam University's Built Environment Department. Within the paper curriculum design and key course developments, with supporting rationale are established. The different cultural aspects of teaching international students are explored, noting how student engagement and behaviour has changed and developed over a 13 year relationship. The paper concludes with the identification of future collaborative ventures.

Keywords: Course Design, Cultural Change and Partnership Development

INTRODUCTION

The Tunku Abdul Rahman College (TARC) Sheffield Hallam University (SHU) collaborative relationship was initially founded in 1999 leading to the design of a bespoke curriculum offering a 60 credit final year Top Up award enabling students to build upon their prior award to achieve an undergraduate honours degree over a 12 week intensive programme of study undertaken at SHU.

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The Department now offers two courses and these have proven to be highly successful, and we are now running into our thirteen year, culminating in some 1800 graduates over the intervening period.

DEVELOPMENT

The initial award was designed using detailed curriculum mapping of the TARC Advanced Diploma (Technology) Building qualification, which is fully accredited by the Chartered Institute of Building and undertaken by the students over a four year period. This led to the development of the highly integrated award of BSc (Hons) Building Construction Management.

The 60 credit level 6 study of the BSc (Hons) Building Construction Management degree at SHU has the specific aim of drawing upon prior learning undertaken at TAR College, so as to challenge the students with holistic construction related problems.

In 2009 due to in country development and industrial demand the sister award of BSc (Hons) Quantity Surveying Studies was developed along similar lines, having been founded upon the newly developed TARC award of Advanced Diploma (Technology) Quantity Surveying. Again the 60 credit Top Up award has the specific aim of drawing upon prior learning but also serves to challenge students holistically from a quantity surveying and cost perspective.

Both awards share two common modules in the form of Integrated Project and Management Theory and Application, which has been highly successful since the emphasis is one of integrative working, which translated well in terms of industrial practices and employability skills.

The two remaining 20 credit modules are of specialist focus and application for each award which serves the students well in terms of their transition into employment. Bespoke specialist and industrial related software applications are employed within a number of such modules, and are very well received by our students.

In 2010 at the request of TAR College and due to local market intelligence a number of changes were made to the curriculum content to enable those students graduating with the BSc (Hons) award in Quantity Surveying Studies to progress to full professional membership of Institute of Surveyors Malaysia by the completion of a small number of professional examinations undertaken in Malaysia. The new curriculum provided the underpinning knowledge for them to take these examinations.

More recently the TARC Advanced Diploma (Technology) Quantity Surveying award is now professionally recognised by the Board of Quantity Surveyors Malaysia in terms of full professional recognition for successful students.

Over the thirteen-year term recruitment has remained strong within a competitive environment due to the broad appeal and overall educational and cultural experience gained by the students.

Upon inception the BSc (Hons) award in Quantity Surveying Studies was initially undertaken by 19 students but this has grown considerably in the intervening period

since 2009 and now recruitment is split equally with that of the BSc (Hons) Building Construction Management award, with an average of 80 students each on both courses.

In terms of more recent developments and founded upon in country demand and future growth the intention is to run a further award comprising of BSc (Hons) Real Estate using the same model and mode of delivery based upon close curriculum mapping of the TARC Advanced Diploma in Real Estate. This award will commence in June 2013.

ISSUES AND CHANGES

Over the duration of the thirteen-year period since inception of the programme a number of reflective changes have become evident.

In terms of cultural change and adaptation students have a clear expectation, mostly from their seniors of what they are to face when visiting the UK and Sheffield for the first time. They are very well prepared in terms of climate, geographical and cultural difference and adaptation to such changes seem easier year on year.

Levels of expectation in terms of the educational, social and cultural aspects of their stay are highly realistic and well known to them.

They appreciate and value the extensive cultural arrangements made for them, the extensive facilities on offer at SHU and the friendliness and security that Sheffield offers.

On a more localised level by exposure to their respective top up award the student skills set and behaviour have changed considerably over the years.

Presentational skills and the ability to work within a collective team environment have been significantly enhanced due to the greater level of exposure through the suite of top up modules.

From the annual feedback provided by the completing students particular value is attached the levels of exposure to a full range of academic staff within and across the module suite, enabling the students to benefit from a host of differing views and work sector related experiences. This is further enhanced by vocationally related hands on activities within modules and site visits designed to contextualise and enhance the learning experience.

Further informative feedback tells us that while happy to work within a team based environment which is reflective of our industry, the concept of autonomous learning is also well received, enabling the students to maximise the significant resource facilities available to them at SHU.

The students particularly enjoy the internationalisation of the curriculum and the vocational relevance that can be transferred ultimately to the workplace.

From the perspective of the academic staff, the students are very dedicated, hard working and committed to their studies. They are very respectful, well behaved and provide a very positive dynamic. This reflects very well in the number of students who complete their studies to a good honours level, which seems to grow year on year.

Upon reflection by contrast to thirteen years ago the students now come over as being more inquisitive and open with their lecturers. They are more vocal and willing to ask questions on an individual basis rather than in a group environment both of which are seen as being most positive developments.

Much of this improvement is directly due to the contribution and dedication of TAR College staff, who are to be congratulated for their excellent work

FUTURE DEVELOPMENTS

Within the Malaysian construction market it is not surprising that the employability rate of completing students lies at over 95% with many working within the Middle and Far East. However employers are continuing to make even greater demands of their construction professionals in the expectation of study to postgraduate level. With this in mind and at the request of TARC, SHU are to launch a blended learning MSc postgraduate progression opportunity of an accredited nature through the Royal Institute of Chartered Surveyors (RICS) and a non-accredited option is also available, both from August 2012.