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FORWARD

Construction is known to play a very significant role in the growth and development of every economy. Indeed, buildings, roads, dams, airports, power plants, stadia, ports and so on are s*ine-qua-non* of development and all these are construction products. It therefore means that construction is the bedrock of development and no country can think, dream and experience development without an efficient and effective construction industry. However, the construction industries of most developing countries have remained a serious concern to all because they lack the capacities and capabilities to provide the enabling environment for sustainable development.

Against this background, the University of Lagos, Lagos, Nigeria decided to host the 2014 edition of the Conference of International Council for Research and Innovation in Building and Construction (CIB) W107 Commission on Construction in Developing Countries. The conference holding in Lagos, Nigeria has as its theme **Construction in Developing Countries and its Contribution to Sustainable Development**. The conference effectively covers all aspects of the theme in five sub-themes. The sub-themes are: Environmental Planning, Design, Management, Technology and Education and Research. In the conference, attempts are made to create a high level of awareness on the importance of **Construction Industry Development Board** (CIDB) through highly educative keynote papers presented by international experts. Further attempt is made to use the conference as a spring board for **Construction Industry Development Board (CIDB), Nigeria** through the **CIDB Stakeholders' Forum** that is planned as part of the conference events.

The conference attracts paper submission from across the globe in particular UK, USA, Australia, Singapore, South Africa, Kenya, Ghana and the host country Nigeria. This reflects the global nature of the conference. In all, 7 keynote papers and 78 research papers will be presented in the conference. The research papers consist of 46 papers on Management, 8 papers on Technology, 6 papers on Design, 4 papers on Education and Training and 14 papers on Environmental Planning. The research papers underwent a two-stage paper review process. The first stage involved the review of each abstract by members of the Conference International Scientific Committee. The second stage involved the review of the full paper of each accepted abstract by at least two members of the Conference International Review and Scientific Committees. The two-stage review process helped to improve the quality and standard of the papers accepted for the conference.

It is the hope of the organisers of the conference that participants would derive significant benefits both in terms of research and professional practice from the keynote and research papers presented at the conference.

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AN INVESTIGATION INTO THE DESIRED ATTRIBUTES OF BUILDING SERVICES STANDARD METHOD OF MEASUREMENT IN MALAYSIA

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Abstract
The continuous increase in the value and complexity of building services has called for the need to present building services cost information in a structured format. There is therefore, a need to develop building services standard method of measurement (BSSMM) and determine the desired attributes in the context of the Malaysian construction industry. These attributes of a standard method of measurement were identified through secondary sources including cross –country comparison of existing standard method of measurement. A Stratified sampling approach was adopted to administer 400 questionnaires to the quantity surveyors in client contracting, and consulting organisations in the Malaysian construction industry These attributes were categorised into three and the results of questionnaire survey was adopted in ranking the variables. The survey result showed that, there is a need to adopt a standard method of measurement for building services. Further, there was agreement among quantity surveyors on the priority ranking of the desired attributes of the standard method of measurement for building services. However, for the standard to be acceptable, it must align with Construction Industry Classification Systems so as to lay an efficient foundation for automation of the estimating process.

Keywords*: automation, building services, estimating, Malaysia, standard method of measurement,*

INTRODUCTION

This article is part of a research project entitled "Sustaining Value for Money in Engineering Services in Malaysia" (SVMES). The primary objective of the research project is to propose the establishment of the building service standard method of measurement that would reflect stakeholder preferences and align local as well as international best practices, so as to enable the presentation of building services cost information in a structured format. The first phase of the study (not reported in this article) investigated the current practices in the cost management of building services, the potentials and the barriers preventing the adoption of a standard method of measurement (SMM) for building services were identified. This paper only considers the need to establish building services SMM and determined the essential features of an SMM that could be modified by industry practitioners to reflect regional factors, such as culture, local best practices, existing industry standards and emerging technology.

Similarly, there is a general increase in the value and complexity of building services in modern buildings because M&E services are currently being integrated with ICT and essentially linked to building energy efficiency, the reduction of carbon emissions, workplace productivity, health and well-being, as well as sustainability enhancement in buildings (McCaffrey, 2011). Thereby, pushing the average cost of building services from the traditional 10 – 25% to 10 – 60%, especially in complex hospital projects and data centres (Davis Langdon, 2010). In the traditional practice, the cost management of building services project is often assigned to building services engineers, mainly as provisional and prime cost sums (PC sums). The services consultants' determine the contract price by way of carefully judged percentage addition to the estimated net building cost as assessed by single price rate method (James, 1999; Buys & Mathews, 2005). The use of single price rate method to forecast and manage 60% of the total cost of a building may not give the long time desired result as it could lead to an unbalanced contract (Flanagan & Tate, 1997; Molloy, 2007; Potts, 2008), and expose the client to a significant financial risk. This is because, the cost of building services are not constant between one project and the other and may be a matter which re

quires separate attention when preparing an early budget estimate (Swaffield & Pasquire, 1999: Swaffield & Pasquire, 2000; Oforeh, 2008). This therefore underscores the need for the preparation of building services bill of quantities in a structured format. In fact, this may be the raison d'être for suggesting the need for specialist M&E Quantity Surveyors to manage the cost of building services, so as to reduce the clients' exposure to financial risk (RICS, 2000; McCaffrey, 2011). It is essentially pertinent to state that, the accuracy and reliability of building services price forecast could be enhanced if the rules of Standard SMM are adopted as basis for its bills of quantities (BoQ). For such SMM to be acceptable, the perspectives of key stakeholders need to be considered. The rationale for this proposition is depicted in Figure 1, and includes:

- The current SMM2 is still in prose format and the preparation was based on the rules of the British SMM6 (The Institution of Surveyors Malaysia , 2000), and therefore, does not reflect local practices and standards;
- The growing awareness in the use of information and computer technology (ICT) in the industry, translate to increasing availability of electronic documents. In addition, the development of automated quantity extraction and estimating systems in five-dimensional (5D) building information modelling (BIM) systems means that adoption of the rules of measurement in SMM2 may be difficult.
- The rules for measuring building services are contained in sections Q and R of SMM2, but the rules have not been adopted for preparing building services BoQ by QS and consultant services engineers. (CIDB, 2009; Sabaria, 2009; Amuda – Yusuf & Mohamed, 2012).

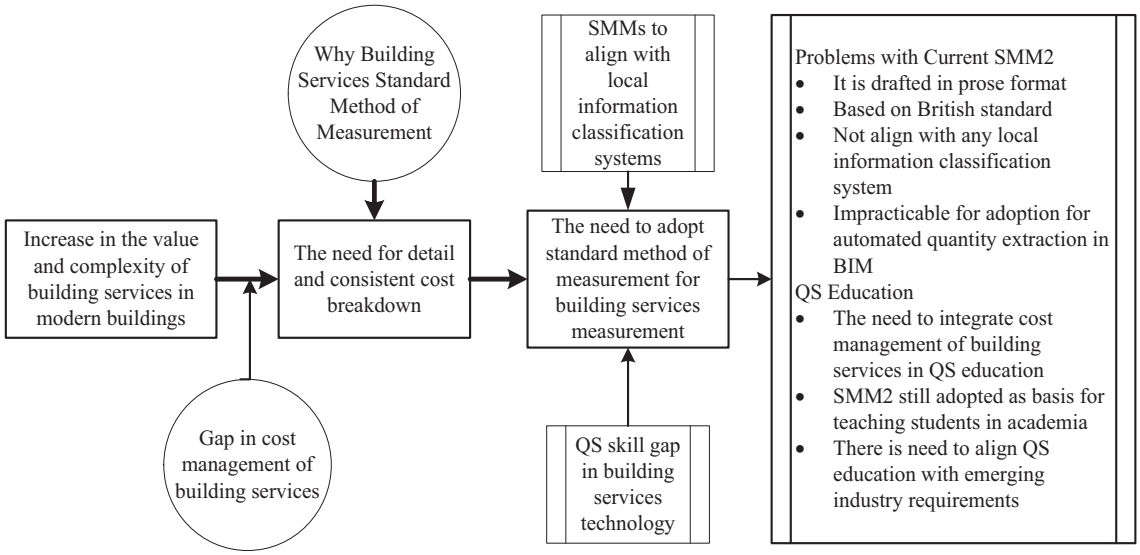

Figure Error! No text of specified style in document.**: Rationale for proposing establishment of building services SMM**

However, empirical investigation into the current practices in the cost management of building services in Malaysia revealed that Quantity Surveyors are not sufficiently skilled in the technology of building services and the consultant services engineers are not conversant with the rules of SMM (Amuda Yusuf, Mohamed, & Remeli, 2013). This therefore reinforced the assumption that the opinion of key industry stakeholders was not comprehensively addressed and there was no evidence that the views of the services consultants were previously considered in establishing the rules of SMM2. The quantity surveyors had adequate knowledge of building structure and fabrics but not building services. Therefore, Quantity Surveyors may need to collaborate with the end –users and consultant services engineers to develop acceptable rules of measurement that could be implemented to provide a framework for cost planning and control of building services procurement. The benefits of a structured format for the forecasting contract price of

building services are aimed at the clients, consultants, contractors, and entire Malaysian construction industry.

LITERATURE REVIEW

Standard Method of Measurements

A standard is a socioeconomic construct reflecting a balance of perspectives between stakeholders (Ahleman, et al., 2009). Ahleman,et al., further explained that it is difficult to differentiate between the classical standards and guidelines issued by professional bodies. Whereas standards are expected to be objective, definitive, and robust, the guidelines issued by professional bodies are open to interpretation. Based on (Ahleman, et al., 2009) explanations, an SMM can be referred to as a classical standard because the rules contained in it have the status of a guidance note, which contains recommendations that meets a high standard of professional competence (RICS, 1998; RICS, 2012).

Many countries of the world have no separate and recognizable system of cost control for construction projects, therefore, cost control functions is performed by architects or the engineer (Iglis, 1992). For instance, in the United States of America (USA) SMM is not used because the US approach towards project delivery and cost control of construction works is different. Kalita, (2007) explained that there is a high level of standardization in the US in terms of M&E services and other building elements because the entire project team is versed in the cost management of a particular building. Therefore, the responsibility of cost monitoring is shared between each member of the project team. The project delivery model in the UK is based on the separation of cost from project management; therefore estimating process involves assisting the design team to develop solutions to meet the clients' requirement Kalita, (2007). The practice requires QS in close collaboration with design team to measure and cost the various resources required for project execution as well as ensuring that the project is delivered to cost, time and quality. The Malaysian construction industry is modelled after the UK (Chan, 2001), and SMM is used as a tool for standardizing the layout and contents of items of construction work.

SMM2 is currently in use in Malaysia and the rules of measuring M&E services are contained in sections Q and R. Kumar (2009) considered that the rules are not adopted because there are no generally accepted Standard Method of Measurement for M&E services in Malaysia; that schedule of prices are often used rather than bills of quantities for M&E services works; where BoQ are used the method of measurement is usually spelt out either in the preamble to the BoQ or in specification and different consultants may have different bills of quantities. Stating the Contractors perspective on the use of Standard Method of Measurement, (Stephen, 2009) confirmed that the lump sum contract is the most popular procurement method for M&E services in Malaysia.

Civil Engineering Standard Method of Measurement (CESMM) was sponsored and published by Institution of Civil Engineers (ICE) and the first edition was published in 1976 (Cartlidge, 2009) while the latest edition CESMM4 was published in 2012. The main purpose of CESMM is to standardize the layout and contents of BoQ and to provide a systematic structure. The main difference between RICS SMM7 and ICE CESMM is that the former has more emphasis on detail whereas the latter takes a more inclusive approach to the measurement process. This is because building work comprises many different trades while civil engineering works consist of a large quantity of a comparatively small range of items. The Malaysian Civil Engineering Standard Method of Measurement was published in March 2012, by the Construction Industry Development Board of Malaysia (CIDB, 2012). A review of some of the existing SMMs led to the identification of their attributes which were categorized as suggested by (Nani, Edwards, Adjei-Kumi, Badu, & Amoah, 2008).

Functions of Standard Method of Measurement

SMM based bills of quantities have been used for the building and civil engineering construction industries for cost planning and control of construction works. It is important to state the primary functions of a standard method of measurement so as to establish the potentials of adopting it for building services projects. The primary functions of standard method of measurement as outlined by (Hughes 1981), includes:

- To standardize the layout and contents of construction work
- Clearly indicating the different circumstances under which items of construction works will be executed
- Indicating the parameters whether standard, special, repetitive or non- repetitive that can significantly affect the cost of construction projects,
- To clearly define the limits of items to be provided to leave no doubt as to what is included, deemed to be included or excluded.
- Prescribing the method and sequence of determining dimensions, and calculating the quantities of measured items

Measurement of Building Services

The measurement of building services can be simplified into three functional elements that apply to all types of supply installations, namely source (e.g., boilers, air handling equipment, transformers, stand-by equipment etc.); distribution (e.g., piping, ducting, cable, wiring, conduit etc.); and outlets (e.g., radiators, air grilles, lighting points, power outlets). Source and outlet elements are usually enumerated, whereas distribution elements are generally measured by length. There are various building services components from different manufacturers with varying quality standards and life span. Since a specific design solution may increase the initial cost of building services equipment but could significantly reduce running cost. It is therefore important that adequate information be given by services engineer before the correct price/cost could be determined prior to installations. Because of the complex nature of building services procurement, where temporary multi-organizations are involved in determining the final design solutions, it is therefore important for consultants to supply concise and accurate information about the exact clients' requirements prior to tender.

BIM and the Rules of Measurement

Building information Modelling (BIM) is an emerging technology that offers the capability to generate, take-off, count and measure directly from a model; however, the type of information on a model and type of cost estimate needed depend on the phase of the project, ranging from high-level schematic models during preliminary phases to detailed estimates as projects enter construction (Sabol, 2008). The Royal Institution of British Architects (RIBA, 2012) pointed out that the methodology adopted by cost consultants to provide and integrate cost information into the BIM model will need consideration along with common methods of outputting area and quantity information into a robust cost plan that would take due cognisance of project-specific cost drivers and market trends.

Matipa et al. (2010) assessed the impact of the RICS new rules of measurement on the cost planning techniques in the BIM environment and pointed out that the quantity resource in Industry Foundation Classes (IFC) schema may not articulate the necessary processes that are covered in the new rules of measurement but could provide the basis of a codified framework for elemental cost planning that, if incorporated into the IFC schema, could enhance the involvement of a quantity surveyor in the provision of early cost management services to the project team. They considered that BIM would make a positive impact on the cost planning process, as it would improve the speed as well as create a consistent approach to the allocation of cost resources. They, however, pointed out the need for cost consultants to consolidate the BIM schema with information about the rules of measurement to improve the consistency and efficiency of BIM-based estimating approaches.

Boon et al. (2011) investigated into the evolution of quantity surveying practices in the use of BIM in New Zealand. They considered that to automate pricing by reference to a standard rate library, it is necessary to develop a coding system and use it consistently, as this is believed to be possible within the current context of BIM development. Boon et al. (2011) stated that the Singapore construction industry seems to have made the most progress in agreeing a coding system to facilitate the exchange of information between computer-based design models and costing systems. They explained that the Singapore Standard CP97: Parts 1 & 2 2002 "Code of Practice for Construction electronic standards" is aligned with Singapore Standards CP 93: 2002 Classification of construction resources information and CP 83: 2000 Construction computer-aided design, to ensure a common classification and coding system is adopted across the industry, which could provide a good basis for rule-based automated quantity extraction in the BIM model.

RESEARCH METHOD

Data Collection

A structured questionnaire was adopted as the survey instrument to measure the theoretical constructs on the need to develop an SMM, the essential features of the proposed SMM that could aid the reliability of the building services estimate. The target sample frame consists of QS in consulting, contracting, clients, and multidisciplinary firms as well as academia. Questions related to the need to develop a building services SMM were measured using a five-point Likert scale with endpoints of "strongly disagree" and "strongly agree". On the essential features of SMMs, a five-point Likert scale with endpoints of "not significant" and "highly significant" was used to measure items. Detailed information about registered consulting quantity surveying and multidisciplinary firms in Malaysia was obtained from the board of Quantity Surveyors website. The list of contracting firms registered and active with selected client organisations in the Southern Peninsular Malaysia in grade categories G5–G7 was obtained and questionnaires were sent to them. The limitations to contractors between grades G5 and G7 was premised on the assumptions that contractors in the lower grade cadre (G1–G4) with a tendering capacity for only jobs ranging between RM 200,000 and RM 3,000,000 may not have QS in their permanent employment.

Sample size

A total of 400 questionnaires were sent out to Quantity surveyors in academia, contracting, consulting/multidisciplinary, and client organisations. In total, 250 questionnaires were sent through the post with a covering letter and a postage paid return envelope. The remaining 150 questionnaires were sent by email to potential respondents. A letter of reminder letter was sent through post and email after three weeks of the initial mailing. Of the 400 questionnaires sent, 14 were returned undelivered because of discrepancies in the address. The letter of reminder and follow-up telephone call as well as meeting respondents at conferences and workshops led to the return of 107 completed questionnaires, indicating a response rate of 27.7%. Nine questionnaires were not properly completed and were deemed to be unsuitable for further analysis and therefore discarded. A total of 98 valid responses were thus received, representing an effective response rate of 25.4%. Previous studies in the construction industry show that the return rate achieved is acceptable. The normal response rate to survey questionnaires in the construction industry is between 20% and 30% (Akintoye, 2002; Dulaimi & Hwa, 2003). Similarly, a 20% response rate was achieved by (Adnan & Morledge, 2003) in a survey of joint venture projects in Malaysia.

DATA ANALYSIS AND RESEARCH FINDINGS

Need to Develop a Building Services SMM

On the need to develop an SMM for building services in the Malaysian construction industry, the results show that from the perspectives of QS, there is a need to develop an SMM for the cost management of building services. A total of 75% of respondents agreed that the use of an SMM would lead to more reliable estimates for building services. On the need for the industry to develop an SMM based on local best practices, 26% strongly agree, 34% agree, and 17% moderately agree, while the remaining 23% disagree.

Approximately 60% of respondents agree that the proposed SMM should be developed along similar lines to those in other countries.

Ranking of the Attributes of an SMM

The essential features of an SMM were identified and grouped under three headings, namely the desired structure of an SMM (14 variables), item descriptors (14 variables), and the determination of the unit of measurement (five variables). Severity index analysis was computed on the sample data to rank the essential features of an SMM in order of their relative importance. Severity indices were used rather than mean scores because the data were ordinal in nature. The frequency analysis was first carried out to obtain the percentage ratings of different variables using a valid percentage derived from the Statistical Package for Social Sciences (SPSS) by adopting the formula in Eq. 1(Idrus & Newman, 2002; Elhag, Boussabaine, & Ballal, 2005):

$$SI = (\sum_{i=1}^{5} wi)\ X\ fi\ \text{x}\frac{100\%}{n}, \text{ ----------} \quad (1)$$

Where *SI* is the severity index, *i* denote the rating scale 1 to 5, *fi* is the frequency of responses, n is the total number of responses, and *wi* is the weight for each rating, while 100% is the valid percentage.

A total of 23 factors maintained a severity index between 65% and 95%. The severity indices of the remaining 10 factors fell between 50% and 65%. This indicates that of the 33 variables identified as the essential attributes of SMMs, only 23 were regarded as significant by quantity surveyors Elhaq,*et al.,* (2005). The summaries of the statistical analyses for structure of SMM are presented in Table 1.

Tests of Agreement between QS

The coefficient of variation (COV) was employed to compare the variability of different responses on the variables as suggested by (Elhag, et al., 2005). The COV expresses the standard deviation as a percentage of the mean as shown in Eq. 2:

$$COV = \frac{S}{c} \times 100\% \quad \text{----------} \quad (2)$$

Where *COV* denotes the COV, *S* the standard deviation, and c are the weighted sample mean.

The results show that the variation in responses on the essential features of SMMs is relatively low, This is an indication that there is a strong agreement between QS on the selected variables. A total of 22 of the 23 factors identified had COVs ranging between 10% and 40%. The COVs for the factors that were not selected were generally higher and ranged between 40% and 55%.

Desired Structure of an SMM

From the perspectives of respondents, 10 variables were considered to be significant under the desired structure of an SMM. Under this category, adaptability for use in the BIM environment ranked first and second overall. This variable has a severity index of about 92%. This ranking might be the result of the emphasis of industry stakeholders on the need to adopt BIM. Practitioners generally believed that the main responsibility of Quantity Surveyors in a 5D BIM model is to integrate design with the estimating function to provide early cost advice on a building project. BIM tools have addressed the significant limitations of 2D drawings that lack the rich 3D context that estimators need in order to identify important cost-sensitive design features. However, according to (Eastman, Teicholz, Sacks, & Liston, 2011), no BIM tool provides the full capabilities of an estimating package, and thus estimators must identify a method that works best for their specific estimating processes.

The development of a local SMM would lead to reflection on local best practices and procedures. This variable ranked second in this category and ninth in the overall ranking with a severity index of about

86%. This finding is in line with the suggestion made by (Ofori, 1994) that imported building regulations and standards used in the developing country's construction industry should be continually revised to reflect the technical, administrative, social, economic, and climatic circumstances of the country. He suggested that such standards should be drafted in a language appropriate to the educational backgrounds of the majority of users. Similarly, reflection on local practices and procedures can also be achieved through the alignment of CICSs and existing industry standards. These basic classifications provide a comprehensive classification system for knowledge of the construction process and for constructing products, which can be used for the storage of both physical media such as catalogues and drawings and digital media in databases (Winch, 2010). International standards for layering Computer – aided designs (CAD) models covered by the ISO 13567 series also rely on ISO 12006-2, while Uniclass incorporates the UK classification standards for the common arrangement of work sections and is therefore compatible with both SMM7 and CESMM3 (Eastman & Liston, 2008). Therefore, to develop an acceptable SMM for use in the Malaysian construction industry, there is need to reflect the preferences for local best practices to create a home ground advantage for clients and professionals. This is particularly important because of the proposed liberalisation of the Malaysian services sector with the tendency of attracting international construction contractors with different construction experiences and backgrounds.

Consideration of cost significant items with a severity index of 83% ranked third and 12th in the overall ranking. Considering the nature of building services, not all items can be measured. In the first phase of this study, practitioners also considered that it is not possible to capture and measure all items of building services. This seems to be in line with the observation that one of the problems of SMM-based BoQs is the large number of small items required for estimating (Ashworth & Skitmore, 1999; Muns & Al-Haimus, 2000; Tas & Yaman, 2005), making it difficult to identify the important items in the BoQ, while considerable effort and time is also associated with pricing the items by estimators. It is therefore essential to note that not all items of building services can be measured; therefore, the identification of major items of building services that are cost significant is essential. Other minor items could be considered as deemed included and describe in the preamble to the bill of quantities. This should be carefully considered in the development of building services SMM.

Building services SMM should be adaptable to all procurement systems ranked fourth in the category and 13th in the overall ranking. This variable is followed by the need for rules to be precise to prevent misinterpretation by users with a severity index of 79%. These two factors are crucial because if the method of measurement is not interpreted in a consistent manner it can be a source of serious error in estimating, and cost control will be complicated. Tendering is generally regarded as a procurement process, while estimating is a predictive process (Dell'lsola, 2002). Thus, Quantity Surveyors often adopt SMMs as a basis to prepare BoQs to invite tenders to submit bids on a proposed project. Therefore, for successful procurement to occur, bidding information must convey equal meaning and portray a clear and unambiguous message to all parties. Other variables identified under the structure of an SMM include easy to locate work item with a severity index of 78%, consideration of cost analysis (76.93%), based on essential best practices (76.50%), concise (avoid unnecessary details) (72.23%), and consideration of local jargon (67.45%).

Table 1: Ranking of the Desired Structure Building Services

Variables	COV	Severity Index	Group Ranking	Overall Ranking
Easy to locate work items	17.35	78.38	6	16
Concise (avoid unnecessary detail)	24.68	72.23	9	20
Precise (rules not open to misinterpretation)	21.59	78.89	5	15
Simple to use	43.05	32.49	14	33
Thorough (logical inclusion of all works)	44.43	36.25	13	32
Reflection of local practices and procedures	15.69	85.87	2	9
Adaptability to all procurement systems	18.16	83.85	4	12
Consideration of cost significant items	17.19	83.20	3	13
Consideration of cost analysis	26.11	76.93	8	17
Based on essential good practices	21.51	76.50	7	18
Consideration of stakeholder opinions	39.81	55.82	12	27
Accommodation for custom classification	28.34	63.84	10	24
Consideration of local jargon	26.25	67.45	11	23
Adaptability for automated quantity extraction in BIM	18.04	91.63	1	2

Description of Work Items

Once construction cost is obtained from the materials, labour, and plant necessary to put the materials/components in place, it is important to identify significant cost drivers and concisely include them in the definition rules of an SMM for describing the items of BoQs. The 10 most important descriptors identified as essential for the identification and estimating of building services components include the background to which the item is fixed, which ranked first in the category and third overall with a severity index of 91%; and location of the work (second, fifth overall, 87%); the identity of the work (third, 86%). Other significant descriptors in descending order of their severity indices were the materials required for the work item; the standard of workmanship required; the quantity involved; treatment of materials involved; dimension of building services components; and handling of materials. This finding corroborates the argument of (Swaffield & Pasquire, 2000) that detailed cost information on building services is required to enable relationships to be established between building services cost and installations as well as establishing a good basis for collecting historical information on building services. Similarly, (Buys & Mathews, 2005) considered building services installations to be unique in nature and that their cost drivers vary from project to project. Therefore, their components need to be separated into smaller segments in such a manner that their costs and cost significant attributes can be easily identified. Hence, early budget estimates for building services installations are unrealistic unless the component design, quality, and marketplace attributes as well as the manufacturer are somehow fixed.

Determination of Measurement Units

The four principal units of measurement in use are enumeration, length, area, and volume. To determine the appropriate unit of measurement, three of the five variables are considered to be significant. The most significant is the physical state of building services components with a severity index of about 93%, which ranked first both under the category ranking and overall. The number of dimensions of components ranked second with a severity index of 88% and an overall ranking of fourth. The third most significant variable is the shape of components with a severity index of about 86%. From the perspectives of QS, these three variables are considered to be significant in the determination of measurement units for building services components. The two factors considered to be non-significant are the unit of quantifying in

the factory with a severity index of 52% and a ranked of number 30 overall and the unit as is available in the local market with a severity index of 44% and a ranked of number 31 overall.

CONCLUSION

Building services constitute a major component in structural and architectural design of modern buildings. Clients' requirements in terms of performance, efficiency, and sustainability enhancement as well as user satisfaction are increasing with proportional increase in its procurement cost. This has led to the demand for effective cost management and the need for specialist Quantity Surveyors to manage the procurement and cost of building services. This paper proposes the development of building services standard method of measurement to serve as a framework for cost planning and control of elements of mechanical and electrical services in buildings. It is, suggested that the procedure adopted for developing the conventional SMM (championed by Quantity Surveyors) and CESMM (championed by civil engineers) may not meet the requirements of building services SMM. Principally, because, on one hand, quantity surveyors are not sufficiently skilled in the technology of building services, as they are with building structure and fabrics. Therefore, they may not be able to comprehend in totality, the variables that affect cost of building services. On the other hand, the services engineers may not be able to follow the approach used by Institution of Civil Engineers (ICE) in establishing the first edition of CESMM because of the interface in the element of building structure and finishes and building services components, which could make independent cost management of these elements a difficult task. Similarly, the consultant services engineers are not conversant with the rules of measurement and contract documentation procedures on building projects. Therefore, there is need for collaboration between services engineers and quantity surveyors to fashion –out strategy to establish acceptable rules for measuring items of building services in Malaysia construction industry.

The study has identified essential attributes of a building services standard method of measurement that should be considered by practitioners so as to reflect stakeholders' preferences, local best practices and create home ground advantage. These attributes were categorised into three namely: structure of SMM; item descriptors and determination of unit of measurement. In order for an SMM to serve its purpose under current industry practices, it is expected to lay an efficient base for automation. The development of a standardised system of classifying information is generally believed to be an important approach to the successful adoption of ICT in the construction industry. This will facilitate the use of a common language between the building services design team, QS, and contractors in the downstream sector of the supply chain.

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AN ASSESSMENT OF THE QUALITY OF SANDCRETE BLOCKS USED FOR CONSTRUCTION IN LAGOS METROPOLIS

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Abstract
Sandcrete blocks have been in use throughout Nigeria and in many parts of the world for a very long time. The prominence of sandcrete blocks as part of the local building materials that make up the wall units in a building or any construction work cannot be underestimated because houses are mostly built of blocks. This paper adopts an experimental research approach in investigating the quality of machine-vibrated hollow sandcrete blocks used on construction sites in Lagos metropolis. A total of sixty (60) units of machine-vibrated sandcrete blocks were sampled from ten (10) manufacturers within Lagos Mainland. Three (3) samples of 450mm x 225mm x 225mm blocks and another three (3) of 450mm x 150mm x 225mm blocks were selected from each of the ten (10) manufacturers to make the total of sixty (60) blocks. Also, a total of forty (40) units of machine-vibrated sandcrete blocks were produced based on the requirements of the NIS 87:2004 standard for sandcrete blocks. The blocks obtained from manufacturers as well as those produced were tested to determine their quality in terms of three parameters which were the compressive strength, density and dimensional tolerances. The results obtained revealed that the compressive strength of the blocks obtained from manufacturers ranged from 0.21N/mm^2 to 1.26N/mm^2 for 225mm thick blocks and from 0.28N/mm^2 to 0.95N/mm^2 for 150mm thick blocks which are far below the minimum standard requirements of 3.45N/mm^2 and 2.5N/mm^2 respectively. The densities of these blocks were found to be satisfactory with the requirements of the standard while the dimensions were found to be inaccurate in terms of web thicknesses. It was recommended that the regulatory and enforcement bodies should be empowered to check and control production processes and the quality of sandcrete blocks.

Keywords: *Compressive strength, quality, sandcrete block, standard.*

INTRODUCTION

Sandcrete blocks are composite materials made up of cement, sand and water, moulded into different sizes. They are widely used in Nigeria and virtually all African countries as walling unit. The quality of blocks produced however, differs from each industry due to the different methods employed in the production and the properties of the constituent materials. Ayeyemi (2008) stated that many factors have been identified for incessant building collapse in Lagos, but that critical step had not been taken to stop manufacturers of substandard sandcrete blocks whose product contributes a lot to the menace and that these blocks are sold by the manufacturers at prices far below what a quality sandcrete block should cost. Oyekan (2007) observed that for a long time until perhaps few years ago these blocks were manufactured in many parts of Nigeria without due reference to any specifications either to suit local building requirements or for good quality work. It is however pleasing to observe that the situation is changing in Lagos state as there have been plans by stakeholders in the construction industry to restore the standards of Sandcrete blocks as the Standard Organisation of Nigeria (SON) now has a document in place giving the specification for both the manufacture and use of these blocks in Nigeria (NIS 87:2004).

The rapid changes in the use of brick to block in Nigeria have encouraged the investigations into the use of sandcrete blocks to be more elaborate (Abdullahi, 2005). The popularity of sandcrete blocks and their extensive application as walling material in Nigeria and other developing countries cannot be overemphasised. The widespread use of these sandcrete blocks has therefore caused heavy demand for it and neces