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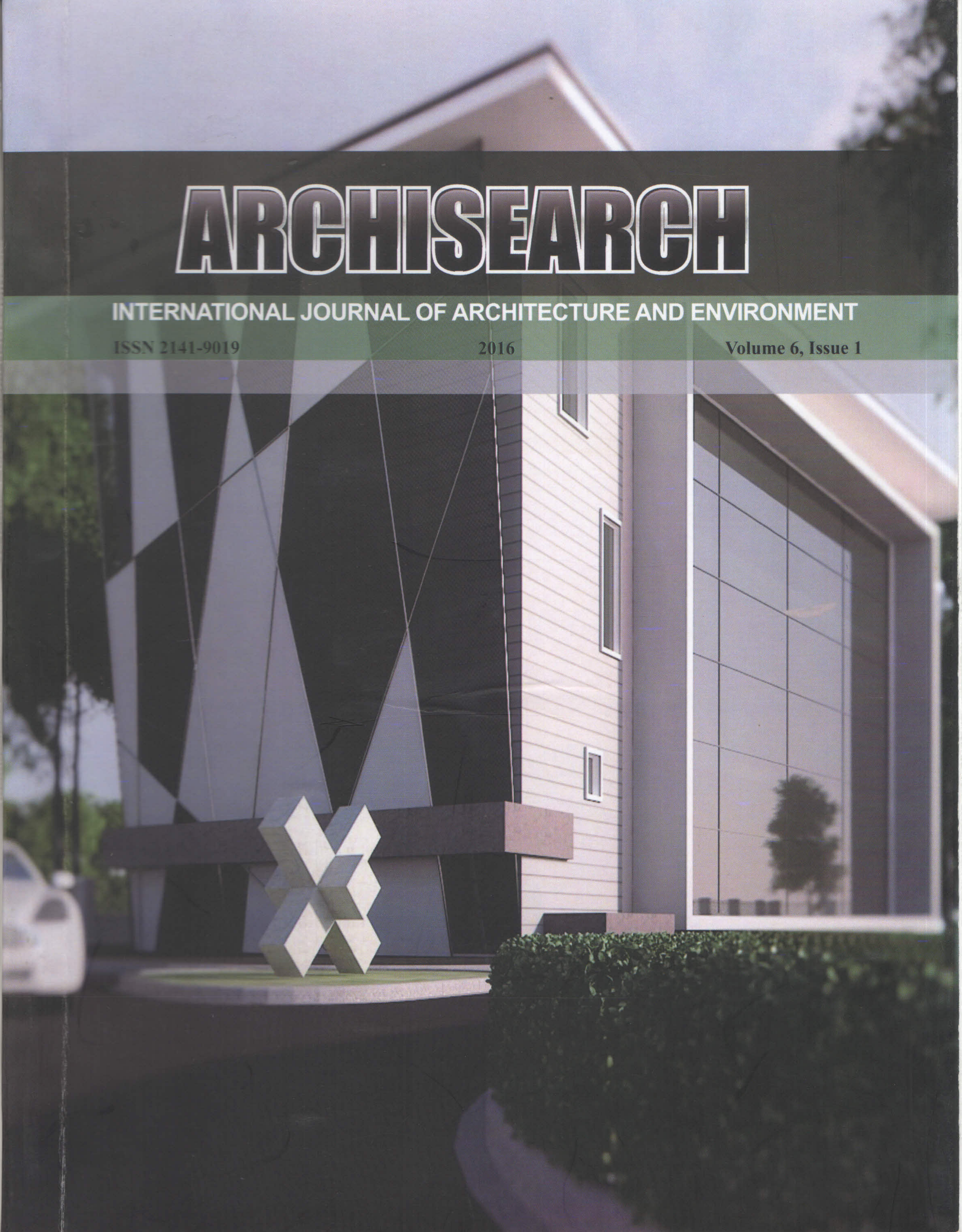

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# IMPERATIVES OF ALIGNING MEASUREMENT STANDARD WITH INFORMATION CLASSIFICATION SYSTEMS

Ganiyu Amuda-Yusuf[1], Taibat Ranti Adebiyi[2], Ibrahim Babatunde Oladapo[3] & Soliu Idris[4]

[1,2,3,4]Department of Quantity Surveying, Faculty of Environmental Sciences, University of Ilorin, Ilorin, Kwara State.

Corresponding author: *amuda.g@unilorin.edu.ng*

**Abstract**

*The automation of Quantity Surveyors (QS) traditional quantity extraction and estimating process is practicable in Building Information Modelling (BIM). However, the existing measurement standards used by Nigerian Quantity Surveyors (NQS) will not facilitate electronic information exchange among project team because it is not aligned with any local industry classification systems. This paper examined the need for the measurement standard used in Nigeria to follow local information classification system which could enable it coordinate with other local product information and naming conventions. The research method adopted is literature synthesis, cross-country comparison and analysis of the classification systems that were adopted as basis for developing measurement standards in selected countries. This was followed by open ended interviews to experienced QS working in clients, contracting and consulting organisations. Content analysis was used to analyse the interview questions. The study reveals that different countries adopted different classification approaches based on their country specific classification systems in developing their local measurement standards, which in turn aids electronic information coordination among project participants. It was also found that, NQS can develop a measurement standard that could provide basis for the development of local information classification systems. Such standards will promote electronic information exchange among practitioners, facilitate speedy comparative evaluation of alternative design solution; assist in ICT adoption by QS, promote the use of e-procurement of construction project, reduce pre-construction documentation period, promote transparency in tender evaluation and promote QS ability to work with other project team members. The research suggests that the construction industry practitioners should collaborate and establish an industry-wide information classification systems that could provide basis for a common ICT platform for project team. Such standard should then form basis for measurement standard development by QS and specification documents by architect and engineers.*

***Keywords:*** *Building Information Modeling, Classification Systems, Collaboration, Electronic Measurement Standard, Quantity Surveyors*

## INTRODUCTION

The wide use of information and communication technology (ICT) in the construction industry is changing the traditional method of project delivery while creating new opportunities for collaboration, coordination as well as information exchange among project participants Arayici, Egbu, & Coates, 2012). Previous studies have shown that integration of project objectives and coordination of project participants is only achievable with the adoption and implementation of a common ICT platform that keeps track of all construction stages and collaboration under a common ICT platform. A need therefore arises to standardise the process for measurement and specify the procedure for procurement through electronic means for seamless collaboration and integration of cost information (Teo, Seah, & Chioh, 2006).

Following the advancement in ICT application in construction industry, QS in more developed countries are embarking on strategies to electronically integrate cost management processes with design and construction, through the development of measurement standards that aligns with construction industry classification systems. A measurement standard which promotes BIM-based quantity extraction and estimating process is required to allow QS to collaborate with other project team in performing their traditional functions (Teo and Heng, 2007; Cartlidge, 2011; Boon and Prigg, 2012; RICS, 2014).

Classification systems constitute the backbone of effective model–based information exchange among construction project participants (Eastman, Teicholz, Sacks, & Liston, 2011). Interoperability issues in the construction industry cannot be easily resolved without a set of rules and principles for classification of information requirements into data exchange specifications (Boon and Prigg 2012; Abdulahi; Abdullahi, & Musa, 2016). These classification systems differ greatly from country to country such as MASTERFORMAT and UNIFORMAT (now in Omniclass) in the US and Canada (Dell'Isola, 2002 Goedert and Meadati, 2008); Unified Classification for the Construction Industry (Uniclass) in UK (Boon and Prigg, 2012; Gelder, 2013); and Building 2000 in Finland because it supports BIM (Firat, et al., 2010).

However, Building and Engineering Standard Method of Measurement (BESMM4) published by the Nigerian Institute of Quantity Surveyors (NIQS) is the measurement standard currently used by the Nigerian Quantity Surveyors (NQS). The structure and term of set-out of BESMM4 is based on RICS New Rules of Measurement (NRM2) without reflecting the philosophy behind implementation of NRM2 in the UK. BESMM4 is not coordinated with any local classification and specification standards used by other built environment professionals. There is a dearth of industry classification and specification standards that links the activities of these professionals for effective information exchange. This is completely different from the practices in other countries where measurement standard is used to organise cost information. For instance, the seventh edition of Standard Method of Measurement (SMM&) was aligned with Uniclass (Cartlidge, 2011; Finch, 2012). While the NRM2 which serves as source document for BESMM4 was align with UK Standard Form of Cost Analysis (SFCA) a document that could also map into Uniclass Gelder (2013). Similarly, the Construction Electronic Measurement Standards (CEMS) in Singapore is aligned with Singapore Standard Code of Practice for Classification of Construction Cost Information (SS CP80:1999) (Boon and Prigg, 2012).

However, the Nigerian Quantity Surveyors (NQS) lags in efforts to ensure that design and procurement information could be electronically shared on a common platform with other project stakeholders (Abdulahi, et al., 2016). Currently, little use is made by NQS of the numerous benefits that BIM offers in terms of capacity to collaborate to receive and share design and cost information with other project team members. According to Abdulahi et al.(2016), the slow pace of BIM adoption by QS is because of lack of conformance of BIM software to local standards such as measurement standards. The authors also observed that the data schema in Industry Foundation Classes (IFC) need to be extended to capture various local standards such as measurement standard and the information requirements establishing the local standards and provisions must be established prior to extension of IFC schema. However, the work of these authors ignored the importance of ensuring that BESMM3 be based on a classification system that reflects local practices in the construction industry before such extension could serve as basis for QS collaboration. Although the adoption of the model could facilitate BIM adoption at project and organisation levels but not at industry level because mere extension of IFC schema as proposed will not still provide good basis for collaboration among industry professionals.

Arguably, IFC's provide a designer-focused product model that explicitly represents components' and openings as an attribute of components (Staub-French, Fischer, Kunz, Paulson, & Ishi, 2002). However, QS have different preferences for describing these different design conditions and the impacts on the construction costs (Towey, 2013). But IFC do not provide a way to filter the component features connections in a way that are defined in the trade-based measurement standard used by Quantity Surveyors (Olatunji, Sher, Gu, & Ogunsemi, 2010; Boon & Prigg, 2012). This is because of the dearth of standard to support systematic data exchange between software applications and BIM models (Sabol, 2008). RICS (2014) considered the need to align BIM-based cost estimating and planning process with measurement standard so as to enhance QS collaboration in BIM environment. RICS explained that project team must agree on a set of requirements which is defined from the viewpoint of cost estimating and planning to enable the QS use BIM more effectively. This paper is an extension to the conference paper by (Amuda, Olowa, & Lateef, 2015) and the focus of this study is to investigate how Nigerian Measurement standard could align with Construction Information Classification System to facilitate electronic information exchange between QS and other project stakeholders on a common ICT platform. This standpoint is based on the supposition that interoperability issues in the construction industry cannot be easily resolved without a set of rules and principles for classification of information requirements into data exchange specifications (Yang and Zhang, 2006; Sabol, 2008; RICS, 2014). The use of classification system as basis for measurement standard development will enable sharing of complex cost information and ensure consistency in a project and from project to project.

This paper is structured as follows: The first section provides information on the relationship between information classification and measurement standards; the second section analyses the basis for

BIM pulled classification of construction information and alignment with measurement standard; the conceptualisation of the need to align BESMM4 with Construction Information Classification Systems, is presented in the third section. This is followed by research methodology and discussion of results. Lastly, conclusion and recommendations are made to industry stakeholders.

## RELATIONSHIPS BETWEEN INFORMATION CLASSIFICATION AND MEASUREMENT STANDARDS

The information classification standards created by the Architectural Engineering and Construction Industry (AEC) are called Construction Information Classification Systems (CICS) and often defined as standard representation of construction project information (Carlos & Soibelman, 2003). The classification structure in CICS according to Klang and Paulson (2000) provided a common framework for improving organisation and coordination of information in construction projects. As the CICS codes serves as key fields for transferring information among project teams and facilitates access and management among project organisations. A CICS must consist of both a Work Breakdown Structure (WBS) for classifying information that comes from actual construction phases and an information management system for classifying materials such as construction product literature, procurement documents, and technical standards (Maritz, Klopper, & Sigle 2005)

It is important to note that, the standardised national classification systems started in the 1950s and 60s, in the Scandinavian countries, and some of the national information classification systems used in other countries include; the Swedish Classification System (SfB), the UK Common Arrangement of Work Sections (CAWS) and Unified Classification Systems (Uniclass); the Singapore's Code of Practice for Classification of Construction Cost Information (SS CP80: 1999) and Code of practice for Classification of Construction Resource Information – SS CP 93:2002, The Australian National Specification Systems (NATSPEC) (Winch, 2010). The use of CICS as basis for electronic measurement standards in selected countries is discussed in the next sections.

### The Swedish Building Classification Systems

The Swedish building classification system (SfB) is one of the most important classification systems in use. The system originated from Sweden and had been in use since 1945 and is still the basis for many existing national knowledge classification systems such as CI/SfB used in the UK (Winch, 2010). The committee that was responsible for the establishment of SfB was called Samarbetskommitten for Byggnadsfragor, from which the acronym SfB was formed. The SfB was centrally adopted in Sweden as the national method for organising official and national construction industry specifications, price books and building product sheets (Maritz, et al., 2005). The SfB system set-out information in such a way that it can be easily stored and retrieved for quick reuse.

The weaknesses in CI/SFB as identified by Winch (2010) are: it applies only to building and not civil engineering; it does not contain classifications for process elements; its coding system is inappropriate for computerisation; new facility types have developed which are not included. The limitations associated with this classification system leads to the publication and adoption of globally recognised classification principles known as Unified Classification for the Construction Industry (Uniclass) in the UK published in 1997 (Winch, 2010). UniClass is the UK implementation of BS ISO 12006-2. The new code of practice, BS 1192:2007 referred to as collaborative production of architectural, engineering and construction information, published in January 2008, recommends the use of Uniclass (Gelder, 2010). Uniclass was adopted as basis for the classification of the revised SMM7 in the UK as explained in ensuing sections.

## The UK CAWS, UNICLASS and Measurement Standards

The CAWS first published in UK in 1987 purposely to promote standardisation and coordination between Bills of Quantities (BoQ) and specifications. It is the document used to set–out the National Engineering Specification (NES), the National Building Specification (NBS), and the seventh edition of the UK standard method of measurement (SMM7) (Seeley and Winfield, 1998). The CAWS comprise of 24 levels "1" group headings and about 300 work sections divided between building fabric and services; section numbers are kept short and cross reference are made to the specification to facilitate consistencies between various documents used on building project (Finch, 2012). Project specifications often prepared by designers and arranged on the basis of the CAWS; this is similarly applicable to the library of clauses in both the NBS and the NES for services installations (Gelder, 2010; Gelder, 2013). The lists of items in each work section are coded to allow for completion of specifications and advice on specification preparation by reference to British Standards (Co-ordinated Project Information, 1987). The overall aim of this is that, if the descriptions in the BoQ are cross referenced to clause numbers in the specification, then the co–ordination of drawings, specifications and BoQ will be improved and the risk of inconsistent information will be reduced (Seeley 1989; Seeley and Winfield 1998; Ashworth 2004; Brook 2008). The major shortcoming of CAWS is that, it does not easily adaptable to computerised applications. The alphanumeric order in CAWS is not ordered in elemental format; therefore, it is not suitable for object naming in the software models. This constitutes one of the reasons for the development and implementation of Uniclass in the UK.

However, Uniclass is a more current classification system published in UK in 1997 for the UK construction Industry (Finch 2012). The Uniclass was made of a new work section classification which incorporates CAWS in Table J and replaces the conventional CAWS published in 1987. Uniclass also incorporates the Electronic Product Information Co-operation (EPIC) which is a new European standard for structuring product data and product literature. The elemental classification of building products is incorporated in Section G of Uniclass (Gelder, 2010; Gelder, 2013). One of the main reasons for this development is the need for classification systems and specification of designs to accommodate civil engineering and process engineering, as well as architecture and landscape. Another reason for the development of Uniclass is the requirement for the classification of works to include a description of all anticipated works that a contractor may carry out on a project. The CAWS cannot accommodate these requirements. The main function of Uniclass system was to unify all available classification systems developed in UK; Uniclass was based on CI/SfB, CAWS, CESMM3 and EPIC and the tables are arranged to represent the different facet of construction information unified with sub-titles and coding system. This approach according to Gelder (2010) and Finch (2012) laid an efficient basis for computer applications and can be used in: establishing product literature; organise project information; developing technical and cost information; structuring frame of reference for databases; set-up Libraries.

**The Singaporean SS CP80: 1999 and SSCP 93:2002**

The SS CP80:1999 was developed to serve the key purpose of allowing the exchange of data and information to guarantee effective communication of design, construction and contractual matters relating to cost through a uniform and accepted classification format. The main components of the standard are: an elemental classification; a work-section classification; a mapping dictionary for elements and work sections and a set of guidance notes. The standard was developed in 1999 by reviewing relevant international standards and an adaptation of a few international standards to suit local use (Productivity and Standard Board (PSB), 1999). Users of this standard in Singapore are property developers, architects, mechanical and electrical engineers, civil and structural engineers, quantity surveyors and contractors. The long-term benefits for users include an efficient information exchange between different parties, reduction in duplication of work between the different disciplines, increased familiarity with a uniform standard leading to an overall increase in productivity for the company as well as the industry. In Singapore, the Construction Industry IT Standards Technical Committee (CITC) formed in 1993 and the Construction and Real Estate Network (CORENET) formed in 1998 for ensuring that national standards are aligned with international standards as well as other industry de facto standards; leading to the publication of Singapore standards (Goh & Chu, 2002):

The Singapore Standard Code of Practice for Classification of Construction Cost Information is to ensure that construction cost information is structured and stored in a way that is consistent and reliable within and between the different disciplines to reduce any duplication of work. In addition, the Code of Practice for the Classification of Construction Resources Information will present a uniform system for classifying information relating to construction products, materials, services and machinery. The main purpose of the standard is to develop and provide a standardised format to facilitate procurement activities in the construction industry as construction projects are used for a broad range of products and services, there is a greater need for a classification standard to ensure a consistent and structured way of information exchange and storage (Goh & Chu, 2002). The Singapore industry appears to have made the most progress in agreeing a coding system to facilitate exchanges of information between computers based design models and costing systems. According to Boon & Prigg (2012) 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.

**The Australian NATSPEC**

The Australian NATSPEC was developed and published by the Construction Information Systems Australia (CISA). CISA established in 1975 with the primary responsibility to develop, produce and maintain the national building specification in Australia. NATSPEC is arranged around work sections that are broken down into subsections, clauses and then sub-clauses (Nani & Adjei-Kumi, 2008). NATSPEC also covers tendering procedures, preliminaries, quality assurance and contract issues. The fifth edition of the Australian Standard Method of Measurement is linked to the structure of NATSPEC. These basic classifications provide a comprehensive classification system for knowledge of the construction process and constructed product 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 the layering of CAD models covered by the ISO 13567 series also rely on ISO 12006. Uniclass incorporates the UK classification standards for the construction process CAWS and is, therefore, compatible with both SMM7 and CESMM3 (Eastman & Liston, 2008).

The classification, terms of set–out, terminology and sections of the fifth edition of Australian Standard Method of Measurement (ASMM5) were aligned with the classification systems in NATSPEC. NATSPEC also covers tendering procedures, preliminaries, quality assurance and contract issues. These basic classifications provide a comprehensive classification system for knowledge of the construction process and constructed product which can be used for the storage of both physical media such as catalogues and drawings, and digital media in databases (Winch, 2010). Therefore, BoQ based on ASMM5 are readily aligned with NATSPEC sub–contract sections. NATSPEC was jointly developed by all key stakeholders in the Australian construction industry. Rationalisation of the rules of measurement in the previous edition (ASMM4) resulted in the deletion of measurement rules for a number of less common items and the introduction of rules of some sections of works that were not contained in the previous editions (Australian Institute of Quantity Surveyors, 1990).

**Conceptualisation of the need to align measurement standard with classification standard**

Recent advances in ICT adoption in construction industry have shown that QS need to collaborate with other project team members to perform their cost management roles and functions. Achieving this will require a measurement standard that could facilitate electronic exchange of construction information on a common ICT platform. The implication of this is that, the traditional standard method of measurement will need to be developed in such a way that it will take cognisance of the method used by other construction professionals to classify and name construction elements. This is referred to as Construction Information Classification Systems.

Classification is described as a means to facilitate communication among actors in a field of practice. In the construction sector, classification plays a significant role in structuring information in specifications, structuring of documents and calculation of costs (Ekholm, 1996). Goh and Chu (2002) opined that there is a need for a common language if the benefits of IT are to be optimised in the construction industry. Mainly because unorganised information is difficult if not impossible to access and therefore as good as lost. On the other hand, if information is properly organised using a common language, it will guarantee timely access for users and speedier transmission and exchange. This will optimise the deployment of scarce manpower for increased productivity and help to make the highly diversified and fragmented construction industry more efficient (Lee, et al.,1989).

Developing acceptable National standards requires engaging key stakeholders and making them understand that standard development is a means and not an end in itself. This is capable of supporting communication between man and man, man and machine and machine and machine(Lee, Leong, Nee, & Chan, 1989). One of the main concerns of industry standard developers (especially SMMs) is the conservative nature of the construction industry. It is quite difficult for the industry to let go of existing practices for new methods, even improved ones. Clients have been identified as the main driver of change in the construction industry (Bourne and Walker, 2006). Consultants and constructors also have considerable influence, but software developers can also be prominent drivers of change. Therefore, in developing and adopting an SMM, it is necessary to evaluate the influence of the various industry players, while keeping in mind Goh and Chu's (2002) recommendations.

However, an examination of BESMM4 showed that the document was not coordinated with any local information classification systems. Rather, the document possessed similar rules of measurement as in NRM2 and the 4th edition of CESMM4. Measurement rules are presented in a tabulated format and are classified under classification table; measurement rules; definition rules; coverage rules; and supplementary information (Amuda-Yusuf, 2016). The implication of this is that, it will be difficult for QS to use the document to collaborate with other project team members to exchange electronic information for automated quantity extraction and estimating process on a common ICT platform (Teo & Heng, 2007; RICS, 2014). For example, proponents of BIM considered that it has the capability for automated quantity extraction and estimating but the rules of measurement would be required to provide the basis for codified framework for cost planning (Matipa, Cunningham, & Naik, 2010). This will enhance the involvement of quantity surveyors in the provision of early cost management services to the project team, resulting to a more reliable and consistent approach in the allocation of cost resources (Arayici, et al., 2012).

However, Boon & Prigg (2012), said that there is a significant non- alignment between the object in BIM models and the traditional trade items in standard method of measurement because the objects in BIM 3D model represent components of the finished product whereas the SMM calls for quantification of the work to create that component. A need arises, for QS to consolidate the BIM Schema with the information from the rules of measurement to improve the consistency and efficiency of BIM based measurement and estimating approaches (Matipa et al. 2010; Abdulahi, et al., 2016)). These reasons underscore the need for the review of the rules of the conventional Standard Method of Measurement in more developed economies like the UK where the use of SMM7 is now outdated (Gelder, 2010; RICS, 2014); The Australian ASMM6 was also rationalised by the Australian Institute of Quantity Surveyors to align with Australian NATSPEC (AIQS, 2016) and Singapore Construction Electronic Measurement Standard (CEMS) (Goh & Chu, 2002).

The structure and term of set-out of the Nigerian BESMM4 is based on RICS NRM2 and is not aligned with any local classification systems. This may make it difficult to provide basis for EMS. This approach may not facilitate the adoption of ICT tools by local industry practitioners as observed by Ofori (2000) that the procurement and contract administrative procedures used in developing countries are those passed on by the western countries. The author considered that Western countries have evolved with different history, culture, collective experience and level of construction expertise. However, the inherited procedures are adopted for contract documentation, procedures, and practices in the construction sector of the various developing countries. Ofori (2000) further considered that, the practices in the countries of origins of these standards and codes have changed to reflect the current technological development. For instance, findings from this study shows that, the first edition of UK SMM7 published in 1988 was based on common arrangement of work sections (CAWS-UK specific classification systems) while the second edition published in 1998 was based Uniclass-also a UK specific classification system). However, the need to meet up with BIM requirements has made SMM7 to be out of date in UK and has been replaced with the NRM2. The classification in NRM2 is based on SFCA systems, but the classification in the NRM2 could still map into both CAWS and Uniclass (Finch, 2012).

Similarly, the Singapore CEMS already made provisions for referencing to IFC under the measurement rules (Yong, et al., 2004). Therefore, the format of the BESMM must lay foundation for this by ensuring that there is provision to expand the measurement rules and coding systems to accommodate the industry classification systems. The use of software in the construction industry has global applications. Software vendors often based the classification in their applications on international standard for specific industry applications. Example of this is Uniclass in UK, NATSPEC in Australia and Omniclass in USA. At this stage, reference must be made to other international standards that other countries have tried to align the rules of their local SMM with. At the same time, provisions will be made to ensure that the standards available and used in other country comply with local preferences in the country. This will ensure that, when Nigerian classification system is fully developed, the classification and coding systems in the BESMM4 will be adaptable to its provisions.

Although, the classification systems in the UK (CAWS and Uniclass) were first developed in the UK before aligning UK SMM7. However, in Singapore, the contents of the standard method of measurement of building works published in 1986 was adopted to provide the local terminology and vocabulary, while UK SMM7 and Uniclass Section J was adopted to provide the framework for the work section classification (Goh, 2002). Therefore, in developing measurement standard the NQS could modify the traditional approach used for SMM development by taking cognisance of the approaches used in other countries.

## RESEARCH METHODOLOGY

The study started with a comprehensive review of literature on SMM development and Information Classification Systems (ICS). The relationship between ICS and measurement standard development were then examined in detail. The review process was supplemented by the personal observations and experiences as well as interaction with experienced industry players. The methodology used for collecting practitioners' opinion was by interview. The targeted respondents are QS working in clients, contracting and consulting organisations. The interview was limited to QS because measurement of construction work is primarily the work of QS and other professionals were neither involved nor interviewed. Snowballing sampling approach was adopted to ensure that respondents have sufficient experience in the use of measurement standard. A number of questions were asked by email and face-to-face interview regarding the structure, development process and the classifications systems used in developing measurement standards. Respondents were told that their views would be reported anonymously and that the outcome of the study will be made available to them. A total of 27 interviews were conducted and the breakdown is shown in Table 1. A total of 30% of the respondents are form-contracting organisation, 26% from clients' organisation and the remaining 44% are from consulting organisation.

*Table 1: Organisations of Interviewees*

| Organisation Type | Interviews Conducted | Percentage |
|---|---|---|
| Contracting | 8 | 30% |
| Client | 7 | 26% |
| Consulting | 12 | 44% |
| Total | 27 | 100 |

*Table 2: Positions of Respondents*

| Designation | Number | Percentage |
|---|---|---|
| Principal Partner | 5 | 18% |
| Managing Partner/Directors | 8 | 30% |
| Contract managers/Estimators | 8 | 30% |
| Managing Directors | 6 | 22% |
| Total | 27 | 100 |

As can be seen in Table 2, 18% of the respondents are principal partners, 30% are managing partners/Directors, 30% contract managers/estimators and the remaining 22% are managing directors. The positions of the respondents show that the interviewees are highly experienced and that the information obtained from them is reliable. The interviews were conducted at the interviewees' own offices and the timescale for the interview ranged between thirty minutes to one and half hour. The interviews were undertaken over a period from February 2016 to July 2016. These questions included asking about the experience of the interviewees' regarding the use of the traditional measurement standards. The reasons for asking these questions were to ensure the interviewee has enough experience to comment on the EMS. After asking the background information, an explanation of what is meant by information classification system was offered before the ''Open-ended'' questions regarding the need for aligning measurement standards with information classification systems in Nigeria. The author explained how such measurement standard can facilitate automated quantity extraction and estimating process, the structure and development process. After the explanations, interviewees were requested to comment on the following points raised:

i. Is it possible for Quantity Surveyors to align measurement standard with information classification systems in Nigeria?
ii. How should information classification system be developed to meet the requirements of local practitioners?
iii. What benefits will result from aligning measurement standards with information classification systems?

Their responses were grouped according to the questions posed and a content analysis was adopted to analyse their responses. Research findings are discussed in the next section.

## RESULTS AND DISCUSSIONS

### Aligning Measurement Standards with Information Classification Systems by NQS

On whether it is possible for QS to align measurement standard with information classification systems in Nigeria, predictably, all the responses were qualified and about 52% of the interviewees fell into the "Yes with comments" while the remaining 48% fell into the "No with comments" categories. The views of the "YES" categories of respondents were that it is possible and that the use of computer applications in measurement is not new by the NQS. The reservations here were mostly about the lack of generally accepted classification system adopted by all professionals as is the case in more developed countries. It was felt that, if developed, the traditional ways of working by Architects, Engineers, Quantity Surveyors and other project team members must be reflected before it can support a seamless information exchange among project participants. One of the respondents felt that the development should be by QS with other experts from the construction industry and implementation should include software companies. Three (3) of the "No" categories of respondents believe that useful standards do not exist and any new development should start from a common local industry practices. About 75% of the respondents agreed that major changes were necessary to make the current BESMM4 match the local industry practices. The need for integration of design, specification and costing as basis for collaborative working was also proposed to the industry.

## Development of information classification systems

On how information classification systems should be developed, respondents to this question all believed on the need for Construction Industry Classification Standards to be the basis for measurement standard that could aid electronic transfer of information. However, they differed on what should be classified or to adopt classification approaches from other countries. For wide recognition, some felt that such classification should be formalised to follow international standard such as ISO which has been used as basis for classifying products information. Another opinion was on the need to use a classification standard developed locally and possibly align with other international standards because classification systems in Europe may be different from that of US. The main issue highlighted by one of the respondents in the "No." category is whether the industry professionals supported the development of such classification standard. The respondent further stressed that, since the importance of such classification systems is not well known, it may not be supported. Another important observation was the issue of adaptability of such measurement standard for BIM model quantity extraction in line with QS practices. This may need consideration to ensure that it is useable in BIM environment to perform the traditional QS roles. Another point raised during the interview was that useful classification standards that can directly meet local requirements do not exist and any new development should start from industry practice and ideas. More classification and data definition work is required locally for such measurement standard to facilitate collaboration among practitioners. These findings also corroborate the work of Gelder (2013) that standard is required to promote efficient collaboration among project participants, and suggested that a single all-embracing national classification system with one structure and philosophy is needed and such classification systems must be able to serve the whole project timeline, all disciplines and all sectors.

## Benefits of aligning Measurement Standards with Information Classification Systems

A key question was "what benefit will result from aligning measurement standards with information classification systems?" Under this question, highlights of the benefits of measurement standards that aligned with information standards were suggested to the respondents. This is to ensure that respondents actually understand and agree with the benefits associated with measurement standards that can support information sharing with other professionals on a common ICT platform. Almost no one questioned that benefits from the use of such measurement standard were achievable and to all involved in the procurement process. The main beneficiary would be the client because of efficiency resulting from collaboration by project team members to work and share information on a common platform. It will also lead to efficient information communication between the project team and the contractors including the project participants at the downstream of the supply chain.

Other benefits as supported by the respondents include:

i. It will ensure that local industry practitioners' views are effectively considered in the preparation of the document since the mode of practices used by other team members will need to be captured and reflected for ease of information sharing.

ii. Promote electronic exchange of information by practitioners.
iii. Development of EMS will facilitate speedy comparative evaluation of alternative design solution.
iv. Development of EMS will greatly assist in ICT adoption by QS.
v. Promote the use of e-procurement of construction project.
vi. Reduce pre-construction documentation period.
vii. Promote transparency in tender evaluation and reporting.
viii. Promote QS ability to work with other project team members

## CONCLUSION

This study has examined the need to align the Nigerian BESMM4 with construction industry information classification system to facilitate QS collaboration in model-based quantity extraction and estimating process. The nature of the construction industry classification systems used in some selected countries were identified and the relationships between their measurement standards highlighted. The study shows that the current BESMM4 would need to align with local industry classification systems to be acceptable to other project team members and possibly be used as basis for developing the local classification systems. Although the Nigerian project delivery model is based on UK practices and the use of standard method of measurement by Quantity Surveyors as basis for bills of quantities is a common practice. However, adoption of the classification systems in UK construction industry or any part of the world may not meet the requirements by Nigerian Quantity Surveyors to collaborate with other project team members at local level. Therefore, for BESMM to define basis for adoption of emerging ICT applications, the layout must be able to map onto a local classification systems agreed by the practitioners (Architects, Engineers, Quantity Surveyors and contractors). Findings shows that development of such measurement standard by Nigerian Quantity Surveyors is feasible. If developed, the benefits of implementing it at industry wide level include involvement of local practitioners, promote electronic exchange of information by practitioners, facilitate speedy comparative evaluation of alternative design solution; assist in ICT adoption by QS, promote the use of e-procurement of construction project, reduce pre-construction documentation period, promote transparency in tender evaluation and reporting and promote QS ability to work with other project team members.

Aligning BESMM4 with classification systems cannot be achieved solely by the Nigerian Institute of Quantity Surveyors. There is need for a collaborative synergy between all the construction industry professionals and they must take a lead in defining the structure of the classification standard. This effort must also involve software vendors to give direction with respect to integration with ICT tools, while Government should provide a policy framework that will facilitate standard development and adoption by the professionals in the industry. The entire industry stakeholders must be involved to reduce barriers to the adoption of the classification standard and the role players must: identify public and private sectors to be involved; determine resources required; select international standards to be revised; and target win-win results among industry stakeholders.

Although this research falls short of developing measurement standards that align with classification system, it clearly provides indicators to industry practitioners on step to take in aligning classification system with measurement standards. The study suggests that the NQS should abandon the idea of merely reviewing RICS measurement standard that is based on UK practice and address the issue of collaborative working with local industry practitioners. This will encourage local-centred and context-sensitive approaches to measurement standard development.

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