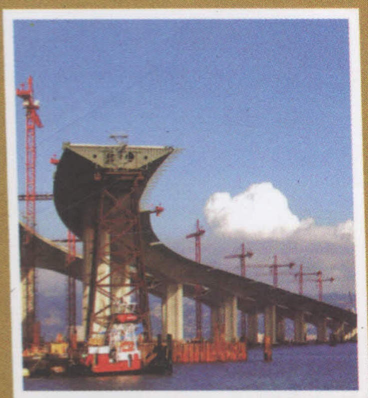
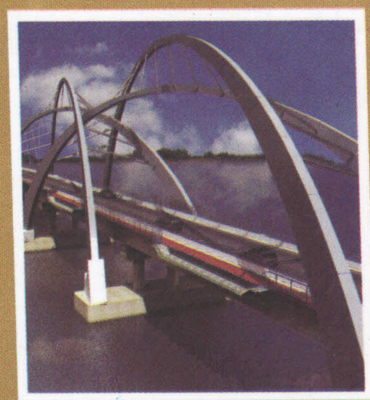
BUILDING INFORMATION MODELLING (BIM)

The Concept, Applications and Benefits in Project Development





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Chapter Three

3.0 BIM INTEROPERABILITY AND INFORMATION STANDARDISATION

By

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3.1 Background

Generallyconstructionindustryiswellknownforfragmentationofworkflow processes with temporary multi-organisations operating at the lowered so the supply chain (Eastman *et al.* ,2011). As a result there is lack of iterations in the design process, lack of consideration of constraints within subsequent phases and lack of leadership and accountability. Other effects of fragmentation include variability of performance, and productivity of projects, design clashes, omissions and hindering knowledge production (Egbu2006). Fragmentation in the industry involves two dimensions: process (construction process) and entities (firms). Fragmentation of process influences fragmentation of entities and this is described by Anumba *et al.*(1997) as“ over-the-wall” approach, where several project stakeholders working dependently or in silos due to construction process separation (Anumba, 2002).

The various parties in the Nigerian construction industry performing isolation by virtue of the individual specialisation and functions in relation to the design, disregarding the significant effects of their design decisions on the other aspect of the entire project. The lack of integration between the various parties involved on construction projects is a real problem that affects the overall productivity and the final quality of the construction industry. Another common problem in the industry, is the use of piece meal solution offered by different soft ware vendors that focus on isolated activities rather than a comprehensive workflow.

The consequences of the same project team using incompatible programs are inability to communicate, collaborate and share project related information with each other in a constructive way. As a result information exchange is mostly constraint to paper work, thereby enhancing the possibility of data loss, corruption and the use of incorrect or unreliable information.

Collaboration and integration of construction project process and the various participants involved is inevitable, as it can enable effective coordination, better communication and achievement of project objectives. Adoption and implementation of Building Information Modelling (BIM) could provide a common platform that keeps track of all construction stages and processes, it has the capability of transforming the traditional fragmented and adversarial method of project delivery while creating new opportunities for collaboration, coordination as well as information exchange among project participants (Teo *et al.*, 2006; Matipa, *et al.*, 2010; Forgues, *et al.*, 2012; Harison & Thurnell, 2015).

BIM is a methodology to integrate digital descriptions of all the building objects and their relationships to others in a precise manner, so that project participants can query, simulate and estimate activities and their effects on the construction process as a life cycle entity (Arayici, *et al.* ,2012). The multi-dimensional nature of BIM, often referred to as 'nDBIM', allows for modelling in an infinite number of dimensions (Harison & Thurnell, 2015). For instance the introduction of Computer Aided Design (CAD) software facilitates the use of 3D models between planning and design phases (Goedert & Meadati, 2008). The four–dimensional (4D) models refers to 3Dmodels linked to a schedule and is used for interference analysis and space conflict identification (RIBA,2012). The five–dimensional (5D) model integrates a 3D drawing with time and cost estimates and could help in accelerating design process and ensuring that client's budget is not exceeded (Boon and Prigg, 2012). The 6D relates to facility management, 7D is sustainability and 8D relates to safety (Harison & Thurnell, 2015).

BIM, including its interchanges, is based on shared digital representation and interoperability allowing computer-to-computer exchanges with the use of open standards. According Building SMART Alliance(2010) BIM represents various meaning depending on its use, for instance:

a) When applied to a project, BIM constitutes information management;

b) When utilised by the design team, BIM represents integrated design; and

c) When used by project stakeholders in general, BIM constitutes an interoperable process for project delivery.

The overall goal of BIM is to create a dynamic model of a facility that can be used by the project stakeholders throughout the building's lifecycle (Young *et al.*, 2007). However, collaboration is essential if the potential benefits of BIM are to be realised as those involved in a project will need to contribute to and access the BIM model, and3DComputer–aided design (CAD) software is intended to facilitate this (Gelder 2013). Furthermore, Gelder (2013) considered 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 time line, all disciplines and all sectors.

The primary focus of this paper is to discuss information classification as the foundation of information standardisation for BIM interoperability. The paper is structured as follows: the first section provides the background to the study, followed by the concept of inter operability; the third section is on information standards and the need for collaboration between construction project process and entities; the fourth section presents information on classification and specification systems in selected overseas countries to support of BIM evolution. This is followed by discussion on the compatibility of the available standards in the Nigerian construction industry; and lastly is the conclusions.

3.2 Collaboration and BIM Interoperability

The multi-dimensional nature of BIM, requires multi-disciplinary project teams to collaborate using BIM software solutions to create, use, and share intelligent 3D digital model information, giving all stakeholders a clearer vision of the project and increasing their ability to make faster and more informed decisions. The construction industry has many contributing disciplines and construction professionals generating information to meet the various demands of a construction project, ranging from architects, quantity surveyors and engineers to contractors and fabricators. Each of these professionals creates specific project deliverables that demand specific and sometime unique data inputs. This creates a complex environment of multiple exchanges between people, disciplines, and project phases. Meanwhile, a widely publicised advantage of BIM is the increased collaboration amongst the project team, achievable through the use of a centralised model (Sabol, 2008). It is hoped that the problems of silo working and badly coordinated documentation in the industry will be greatly reduced through the adoption of BIM.

Collaborative working is a key feature of BIM with the potential to leverage social relationships and interactions, decreasing conflicts and opportunism within teams and throughout supply chains. According to RICS (2015), significant benefits can accrue from effective collaborative relationships as a result of better information flows which include:

- More accurate information about products and services supplied enables better coordination and in life-cycle terms enables better facilities management;
- Better information leads to better coordination and enables more effective planning for suppliers as well as clients and main contractors;
- Better information enables more effective construction sequencing, reducing the chance of clashes and enabling clash detection;
- Betterinformationenablessociallearningsothatdifferentsupplierscanle arn from each other about best practice tools and techniques;
- Betterinformationreducesopportunismbymakingitmoredifficultbecau se information is more transparent and easier to retrieve.

BIM is all about structured information that is coordinated and clear information flows enable clients to articulate their needs more plainly and in-turn the tendered can be more responsive to clients' questions. However, for the benefits associated with collaborative working to be successfully annexed by industry practitioners, inter operability is critical.

Azhar *et al.* (2012) describes interoperability as the ability of different software systems to exchange data information. Similarly, Gallaher *et al* (2004) considered interoperability as the **"ability to manage and communicate electronic product and project data between collaborating firms and within individual companies, design,**

construction, maintenance, and business process systems". Interoperability is the smooth sharing of information across all BIM applications and disciplines involved, which is required for business benefits to be maximised. In order to achieve this, data exchange standards are require to help project teams move information from one 3D modelling software application to another without loss of data reliability, thereby facilitating more efficient workflows and higher quality outcomes. There are different types of information standards available in the industry for information exchange. These standards and their features are explained in the next section.

3.3 Information Standards

The information standards used for data exchange in the construction industry range from middle ware software, exchange file formats developed by individual proprietary software vendors such as DXF (Data exchange Format), standards and open-specification data models like XML (eXtensible Mark up Language), IFC (Industry Foundation Classes), Web Services, deployed for distributed databases ICT (Information and Communication Technology), project model servers, and semantic Web applications (Yangand Zhang, 2006). Some of the information standards used for construction information exchange is shown in Table 3.1

Table 3 1: Information standards and their Application

Information	Application
Electronic Data Interchange (EDI)	EDI is the direct transfer of structured business data such as payments, receipts, requisitions etc, between firms by electronic means. EDI has been very successful in a number of industries that have very high transaction volumes (e.g. banking, retail and manufacturing industries)This is used for direct transfer of structured business data but rarely used in construction (Ingirige, *et al*., 2001)
File Transfer using DXF and DWG Formats	CAD based software for building design and civil engineering structures used DXF and DWG file formats to transfer design details and drawings electronically. However there was very little integration brought about by these electronic file transfers, but this form of exchange marked the beginning of information sharing in the construction industry (Ingirige, *et al*., 2001)
Standard for Exchange of Product Model Data (STEP)	STEP, also known as ISO 10303, is an international standard capable of describing product data independently from any particular system and throughout the lifecycle of a product, from design to manufacturing, using the product and the disposal. STEP contributes to a neutral file exchange used as a base for storing and sharing product database. It has been instrumental in fostering collaboration and communication within supply chain teams. Since its beginnings in 1984, STEP is being continuously developed, used in various industries including AEC, aerospace, automotive, and shipbuilding. Used mainly in manufacturing industry for the transfer of product details but has influenced the development of product model such as IFC in the construction industry (Ingirige, *et al*., 2001; International Organisation for Standardisation, 2010).)

Industry Foundation Classes (IFC)	Represent a data structure that facilitates data sharing across applications and allow each discipline in the construction industry to clearly define their view about the objects. This is based on the International Alliance for Interoperability (IAI) specifications. IAI specifies the way physical objects such as doors, walls, windows etc. and abstract concepts such as space, the organisation should be represented in electronic format. Software is being developed based on the universal IFC specifications to create specific applications in the construction industry. For example a fan object created in one application (e.g. by an architect) can be exchanged with and used in another IFC compliant application (e.g. by an electrical services engineer), which enables application integration (Ingirige, *et al.*, 2001; International Organisation for Standardisation, 2010).
Construction Operation Building Information Exchange (COBie).	Construction Operations Building Information Exchange (COBie) is a non-proprietary data format for the publication of a subset of building information model focused on delivering asset data as distinct from geometric information. Simply put, COBie is a format used for overview reports on what is in the building, what kind of jobs is involved, and who is responsible for what. The person who has created the COBie also refers to it as an IFC Model view. The primary benefit of COBie is that it enables information to flow from the design phase, allows information to be added during construction and is available to deliver the information to the facility manager upon completion. Many organisations are now requiring COBie for their projects and more will be doing so in the future.
Extended Mark-up Language and web standards (XML)	This model is used to integrate data from different sources that are dispersed and presented in various format. XML mark-up retains the intelligence of the data throughout the processing chain. It is similar to IFC but the volume of information processed by XML mark- up .is smaller (Ingirige, *et al.*, 2001)

However, interoperability issues in the construction industry cannot be easily resolved without a set of rules and principles for classification of information requirements in to data exchange specifications. Classification systems constitute the back bone of effective model based information exchange among construction project participants (Eastman *et al.* ,2011). Classification systems differ greatly from country to country such as MASTER FORMAT and UNIFORMAT in the US and Canada (Dell'lsola, 2002) (now in Omni class); Goedert and Meadati, 2008); Unified Classification for the Construction Industry (Uniclass) in UK (Boonand Prigg, 2012; Gelder, 2013); and Building 2000 in Finland because it supports BIM (Firat, *et al.* ,2010). Ashworth (2011) explained that BIM originates from the USA and their classification systems have never been compatible with the UK practice, moreover; Europe uses different procedures from UK. In the Nigerian construction industry, the use of information classification and information standards as a means of information exchange among project participants is not widely practiced. If available, it is used at individual organisational level and not generally adopted.

3.4 Classification Systems

Proponents of BIM have pointed out that collaboration is key to BIM adoption and industry wide implementation (Eastman, *et al.* ,2011). Collaboration is defined as working with others, not working for others. Some argue that procurement and payment practices will also have to become collaborative before BIM can work properly (RICS, 2015). Some scholars have argued that it will be difficult to significantly change existing work processes to enable seamless implementation of new technologies such as BIM, as the working practice of construction project management teams ... e already well structured around generally accepted construction project management practices (Hartmann *et al.* ,2012; RICS, 2014; RICS, 2015). Example of the traditional process used in the industry is the information classification standard used to coordinate design, construction and cost information among project participants.

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 and Soiberman, 2003). The classification structure in CICS according to Klang and Paulson (2000) provides 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. ACICS must consist of both a work break down 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 *et al.*, 2005).

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–SSCP93: 2002, and the Australian National Specification Systems (NATSPEC) (Winch, 2010).

3.4.1 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 "*Samarbetskommittenfor By ggnadsfragor*", 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 re use.

The SfB system formed the basis for UK classification, but 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). UniClassis the UK implementation of BSISO 12006-

2. The new code of practice, BS1192: 2007 referred to as collaborative production of architectural, engineering and construction information, published in January 2008, recommends the use of Uniclass (Gelder, 2010).

3.4.2 The UKCAWS and Uniclass

The CAWS first published in UK in 1987 purposely to promote standardisation and coordination between BoQ and specifications. The CAWS comprises of 24 levels "1" group headings and about 300 work sections divided between building fabric and services, section numbers are kept short and cross references are made to the specification to facilitate consistencies between various documents used on building project. The lists of items in each work section are coded so as to allow for completion of specifications and advice on specification preparation by reference to British Standards. The overall aim of this is that, if the descriptions in the BoQ are cross referenced to clause numbers in the specification, then the coordination of drawings, specifications and BoQ will be improved and the risk of inconsistent information will be reduced (Seeley, 1989; Seeley & Winfield, 1998; Ashworth, 2004; Brook, 2008).

Project specifications are usually prepared by designers and arranged on the basis of the CAWS, This is similarly applicable to the library of clauses in both the National Building Specification (NBS) and the National Engineering Specification for services installations. It is the document used for set–out of National Engineering Specification (NES), the National Building Specification (NBS), and the seventh edition of the UK standard method of measurement (SMM7). The lists of items in each work section are coded so as to allow for completion of specifications and advice on specification preparation by reference to British Standards. 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 & Winfield, 1998; Ashworth, 2004; Brook,2008).

"Uniclass" is a much more current classification system for the UK construction Industry and was first published in 1997 (Uniclass1). The Uniclass 2 was published in 2013 by CPI. The Uniclass is 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 an European standard for structuring product data and product literature. The elemental classification of building products is incorporated in Section Gof Uniclass. One of the main reasons for this change is the need for classification and specification to accommodate civil engineering and process engineering, as well as architecture and landscape. Another reason for change is the need for the works classification to cover the description of all works a contract or may carry out on a project. Therefore, the classification need homes for every conceivable system to describe systems in performance terms and CAWS cannot accommodate this.

The main function of Uniclass2 system was to unify all available classification systems in UK. Uniclass was based on CI/SfB, CAWS, CESMM 3 and EPIC and the tables are arranged to represent different facet of construction information unified with sub-titles and coding system. This approach according to (Gelder, 2010; Finch, 2012) laid an efficient basis for computer applications and can be used in:

- Establishing product literature
- Organising project information
- Developing technical and cost information
- Structuring frame of reference for databases.
- Setting up Libraries

However, experts from across the industry have revised Uniclass 2 and developed the new system, known as Uniclass 2015. Uniclass 2015 has been restructured and redeveloped to provide a comprehensive system suitable for use by the entire industry, including the infrastructure, landscape, and engineering services as well as the building sector and for all stages in a project life cycle. The reason for the review is to make it more suitable for use with modern construction industry practice, and to make it compatible with BIM now and in the future (National Building Specification (NBS),2015)

3.4.3 The American Uniformat, Master format and Omniclass

Uniformat and Master Formats are widely used in the United States of America and Canada. Uniformat was developed in the early seventies and enhanced in the nineties to organise information for estimating and design costing analysis of a projects major component. Uniformat is a uniform classification system for organizing preliminary construction information into a standard order on the basis of systems and assemblies without regard to the materials and methods used to accomplish them. Uniformat is mainly used at the early design stage of a project for preliminary project descriptions, performance specification and cost estimating. The Masterformat breaks down the information by work results or construction practices that result from a combination of products and methods and the information is used throughout the facility cycle (Dagostino *et al.*, 2008).

However, the growing experience with classification systems and the development of ICT led to the development of Omni Class for entire North American Market. It is developed for North American architectural, engineering and construction (AEC) industry by the Construction Specifications Institute (CSI) (Gelder,2010). The Omni Class is a Construction Classification System (OCCS) for the construction industry. It is a multi-table system for organising information used by the architectural, engineering, and construction industry. OCCS is used to organise project information, to providing a classification structure for electronic data bases. It incorporates other classification systems currently in use as the basis of many of its Tables such as Master Format for work results, UniFormat for elements, and EPIC (Electronic Product Information Cooperation) for structuring products. OmniClass establishes a terminology library that can be used to explicitly identify objects and their parts by associating their names with the actions and resources that make them up. In the practice of building information modelling, objects that are associated with terms in an OmniClass library, inherit standard sets of properties and pre-defined relationships with other "concepts" in the OmniClass definition frame work, by this association (Sabol,2008).Similarto UK Uniclass, OmniClass builds on ISO12006- 2 (ISO/FDIS 12006-2, 2001).

3.4.4 The Singaporean SS CP80:1999 and SSCP93:2002

The SSCP80: 1999 was developed to serve the key purpose of allowing the exchange of data and information so as to guarantee effective communication of design, construction and contractual matters relating to cost through a uniform and accepted classification format. The standard was developed in 1999 by reviewing relevant international standards and an adaptation of a few international standards to suit local use. 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.

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 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) formedin1993 and the Construction and Real Estate Network (CORENET) formed in 1998 for the purpose of ensuring that national standards are aligned with international standards as well as other industry de facto standards. Leading to the publication of the following Singapore an standards (Goh &Chu, 2002):

- Code of practice for classification of Construction Cost Information- SSCP 80:1999
- Code of Practice for Construction Computer – Aided (CAD) – SS CP 83:2000:2004
- Code of practice for Classification Construction of Construction Resource Information– SS CP 93:2002.
- Code of Practice for Construction Electronic Measurement Standards (CEMS) (in 2 parts)– SS CP 97 2002: 2003; and
- Code of practice for Information Exchange and Documentation at Handing/Taking–Over Building upon Completion.

The main purpose of the standards 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 greater need for a classification standard to ensure a consistent and structured way of information exchange and storage (Goh &Chu, 2002).

3.4.5 The Australian NATSPEC

The Australian NATSPEC was developed and published by the Construction Information Systems Australia (CISA). CISA was established in 1975 with the primary responsibility to develop, produce and maintain the national building specification in Australia. NASPEC is arranged around work sections that are broken down in to subsections, clauses and then sub-clauses. NASPEC also covers tendering procedures, preliminaries, quality assurance and contract issues. The fifth edition of 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.

3.5 Information Classification and Measurement Standards

Following the advancement in ICT applications and BIM evolution in the construction industry, Quantity Surveyors 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. For instance in the UK, the Seventh edition of the Standard Method of Measurement (SMM7) published in1988 was based on common arrangement of work sections (CAWS-UK specific classification systems) while the second edition published in 1998 was based on Unified Classification for the Construction Industry (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 RICS new rules of measurement (NRM2). The classification in NRM2 is based on Standard Form of Cost Analysis (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. Electronic Measurement Standards (CEMS) in Singapore is aligned with Singapore Standard Code of Practice for Classification of Construction Cost Information (SSCP80:1999) (BoonandPrigg,2012). While, the classification systems in the UK (CAWS and Uniclass)were first developed in the UK before aligning UKSMM7, 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 UKSMM7 and Uniclass Section J was adopted to provide the framework for the work section classification (Goh,2002). The

Australian ASMM5 was also rationalised by the Australian Institute of Quantity Surveyors to align with Australian NATSPEC (AIQS, 2016).

3.6 Classification/Codes/Specification Standards in Nigeria

Are views of the construction industry practices in Nigeria shows that there is a dearth of information classification standards jointly used by practitioners to support information sharing on construction projects. One of the documents identified by the author that shows combined efforts by the industry professional is the National Building Code established in 2006. An impressive feature of the Code that is similar to standard development in overseas countries is that, the Code was developed by a committee that comprised the full spectrum of the representatives of the built environment professionals among others.

The aim of the National Building Code as stated in the document "is to set minimum standards on Building Pre-design, designs, construction and post-construction stages with a view to ensuring quality, safety and proficiency in the building Industry". The Code sub divided the entire building process into four (4) stages as:

a) Pre-Design Stage;

b) Design Stage;

c) Construction Stage;

d) Post construction Stage

One of the reasons for evolving the Code as stated in the document is the dearth of referenced design standards for professionals in the country. One would expect that such Code will provide a classification standard that could be referenced for the purpose of design and specifications. Instead, the Code only classified building design by use and construction by type. The standard is too open to interpretation; it is mainly for building works and failed to classify buildings either by work sections or elemental format. The code is not linked to any specification standard in Nigeria and seems not recognised as a legal document/standard in Nigerian practice. Though reference could still be made to the code for specifications but it is unfit to serve as basis for the classification of construction information.

Specifications writing by Architectural practices in Nigeria are largely based on individual organisation practices. Architectural firms largely extract specifications from manufacturer's catalogue for integration into their design. There is lack of unified method of arranging construction information in a manner suitable for seamless information exchange among practitioners.

Another standard used in Nigeria is the Standard Method of Measurement used by Quantity Surveyors which is in its fourth edition. The fourth edition of the documents is named Building and Engineering Standard Method of Measurement (BESMM4) published in 2015 by the Nigerian Institute of Quantity Surveyors. It is a review of BESMM3 (based on UKSMM7) and is a combination of the method of measuring building, civil and industrial engineering installations. The document reflects organised construction information.

The structure and term of set-out of the Nigerian BESMM4 was based on RICS NRM2. A major shortcoming of BESMM4 is lack of coordination with local classification and specification. Currently, it appears there are no construction information classification system and specification standards in the country to which BESMM could be aligned. There is no evidence to suggest that the publishers of the BESMM4 consulted with other industry stakeholders in the development of BESMM4 apart from quantity surveyors. This approach is quite different from the approach adopted in the development of UKSMM7,RICSNRM2, the Singapore CEM Sand the rationalisation of ASMM5. Unless the rules of measurement standards reflects local industry practices it may not provide basis for collaboration with other project participants and will not facilitate the adoption of ICT tools by quantity surveyors.

It is apparent that the classification systems from various countries are generally very similar in structure and contents. Their main users are the construction industry stakeholders. However, the use of the classification systems varies in the individual countries perhaps as a result of the different working methods employed. The classification systems also provide interfacing facilities to the construction information systems. There by providing all project participants with the information and platform they needed for specification writing, preparation of Bills of Quantities, information standardisation and data exchange on common ICT platform. This is missing in the Nigerian construction industry leading to:

- Ineffective utilisation of modern ICT tools such as BIM;
- Lack of construction product information;
- Lack of effective communication between various local industry practitioners;
- Lack of home-based advantage for local practitioners;
- Inefficient application of available resources;
- Lack of quality and reliability of the final product.

3.7 The Way Forward

A starting point to BIM adoption is the establishment and implementation of construction information classification system for use by the entire Nigerian construction industry. This is highly foreseeable and when such standard is developed and implemented, it will enable projects take holders to exchange general and specific project information through BIM compliant information standard or other electronic means rather than communicating through the traditional paper-based methods. The main sources of guidance used in other overseas countries for the development of national information classification systems are ISO1 2006-2, Building construction- Organisation of information about construction works-Part2: Framework for classification" (e.g. UKU niclass 2015 & USO mniclass). In addition, in the development of national information classification standards for construction cost and resources in Singapore an construction industry, Goh & Chu (2002) suggested that the standard developers should adopt the following steps:

a) Make a conscious efforts to involve industry players in the development of the standards in order to help bring down barriers to change;
b) Keep the standards as simple and concise as possible;
c) Adopt a two-stage approach so as to achieve a win-win results
d) Identify leaders in the industry (in both private and public sectors) who can drive the development of standards in order to convince other players to follow suit; and
e) Develop assistance schemes to help small and medium firms embrace standardisation and IT.

Based on the afore mentioned, it is suggested that consideration be given to the adoption of a similar strategy followed by the overseas countries, alongside, a committee should be set-up which is similar to the committees for the development of National Code to spear head the development of the Nigerian national information classification systems for the construction industry.

Similarly, a national work groups representing each disciplines in the built environment should be setup to fashion out modalities for developing national specification standards that would be linked with the national information classification systems. A comprehensive national specification standard would provide standardised specification in all construction areas and should be developed in such a way that the information classification systems are linked to:

- National Building Code;
- Architectural specification standards (for building specification);
- Engineering specification standard (for engineering specification);
- Cost information systems (for historical cost records); and
- Standard method of measurement for construction works (measurement of construction works).

Apparently, this would be a long term project and only realisable if an independent construction industry development board is evolved to transform the Nigerian construction industry to an industry that is vibrant and resilient to our epileptic political systems. Such body is best suited to control the development, publication and maintenance of the information classification and specification standards in the country.

A need arise for the formation of an Association of Construction Industry Professionals as a non-governmental pressure group to come up with a workable road map to revamp the Nigerian construction industry by persistently advocating for best practice and recognition of the indigenous practitioners in all construction projects.

3.8 Conclusion

There is enough evidence to suggest that the rapid evolution of BIM technology in the global construction industry and its revolutionary impact on the relationships between industry practitioners will definitely creep into Nigerian construction industry. The main focus of this paper was to report on the need to evolve a workable system that could support interoperability in BIM model. This will require changes in the project delivery methods and the roles of professionals in the industry may change. In addition, the following technology will be essential to facilitate information exchange among practitioners:

- Integrated knowledgebase applications with capabilities to enable all construction parties to work simultaneously on a proposed project model;
- Computer based communication networks; and
- Electronic data interchange.

Therefore, the paper has mainly identified the importance of information classification as a way of ensuring information standardisation and seamless information exchange among project participants. This paper has also indicated in strong terms that a need exists for the development of construction information classification systems and specification standards for the benefit of the entire industry stakeholders. It is postulated that, the success of classification standard development rest on the ability of the construction industry stakeholders to ensure the establishment of an independent construction industry development board to oversee the activities of the industry.

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