ADOPTION OF BUILDING INFORMATION MODELING AND NIGERIA'S QUEST FOR PROJECT COST MANAGEMENT

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SUMMARY

The relevance of Building Information Modeling (BIM), a "*shared knowledge resource for information*", to proper budgeting and achieving value for money in construction projects has been well established. This paper examines the actual and potential roles of BIM in achieving better budgeting and cost management in public construction projects which still dominate Nigeria's construction sector. It starts with a discussion of the tools and practices which BIM bring to bear on construction projects, focusing particularly on those that are relevant to budgeting and cost management. It then discusses cost management practices in Nigeria and current efforts to promote transparency and value for money in public construction projects by the Federal Government of Nigeria, professional bodies and civil society groups. It analyses the adoption of BIM in Nigeria's construction industry and makes recommendations regarding its successful diffusion and use as a cost management tool.

Understanding Building Information Modeling

Building Information Modeling (BIM) is an approach to construction that supports the continuous and immediate availability of projectdesign scope, schedule, and cost information that is of high quality, reliable, integrated. According to Sacks et al, BIM is a generic term used to describe advanced 3D Computer Aided Design (CAD) technology for modeling and managing buildings and information related to them but which are differentiated from traditional CAD systems in that the software objects in a BIM model are intelligible to computer programs as representations of real-world building components, unlike the graphic objects in a two-dimensional CAD file" (Sacks *et al*, 2005).The American Institute of Architects (AIA) defines BIM as "a model-based technology linked with a database of project information". BIM covers geometry, spatial relationships, geographic information, quantities and properties of building components. According to Matta et al, "technology advances instigated transition of design medium from 2D paper-based drawings to 3D digital models on computer screen - led to the introduction of Building Information Modeling (BIM)". BIM is regarded as the latest generation of object-oriented computer aided design (OOCAD) systems inwhich every component of intelligent building objects that combine to make up a building design is able coexist in a single 'project database' or 'virtual building' that captures everything known about the building. A building information model (in theory) provides a single, logical, consistent source for all information associated with the building (Howell and Batcheler: 2005).

Quantity surveying entails the accurate interpretation of designs and numerical representation of component quantities which was for a long time a process carried out through manual means. This makes it prone to errors and also very laborious. CAD applications were adopted which were able to represent 2D geometry via graphical elements such as lines, arcs, symbols etc. Later it became possible, through layering, to project significant meaning through the graphic elements, by grouping related elements, such as lines representing walls on a particular "wall layer". Thus, discrete 2D drawing files could be generated and plotted from CAD. But it was not possible to represent more complex information such as the relationship between elements. Later, 3D CAD emerged, focusing mainly on creating geometry supporting visualization but later became capable of the creation of realistic rendering and lighting effects.

Later advances have seen the evolution of object-oriented CAD systems (OOCAD) replacing 2D symbols with building elements that are capable of representing the behavior of common building elements displayed in multiple views and having non-graphic attributes assigned to them. This allowed the representation of complex geometric and functional relationships between building elements through the inclusion of parametric 3D geometry that possess variable dimensions and assigned rules, which thus added "intelligence" to the objects. This made it possible to stretch objects such as walls, join them, indicate height and a specific cross-section type as well as endow them with associated property such as fire rating or insulation value. Doors and windows, represented as objects, became capable of representing their relationship with the wall containing them. Critically considering the evolution towards BIM, abstract objects such as space, could be defined through the relationship between physical building elements and identified, for instance by giving a room a number or name and also described, for instance by area, occupancy, volume etc. and referenced i.e. listed in a room schedule.

It is worth noting that 3D geometry is only part of the BIM. The relationship can be captured thus:

- M = geometry
- I = information shared to generate feedback and for decision making
- B = building

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A basic premise of BIM is collaboration by different stakeholders during different phases of project life cycle which makes it possible to insert, extract, update or modify information in the BIM process to support and reflect the roles of that stakeholder (NBIMS Project Committee, 2006). BIM was conceived to remedy the problem of fragmentation and error by creating a system to house or manage all of the information needed in a particular project in a single repository that could be accessed by all project participants and readily incorporated into all project documents (Cyon Research, 2003; Khemlani, 2003).

The benefits and key advantages that BIM confers include:

- Increased speed of delivery (time saved)
- Better coordination (fewer errors)
- Decreased costs (money saved)
- Greater productivity
- Design visualization
- Reduction of Errors
- Collision Detection
- Quantity Take Off
- 4D Constructability
- 5D Cost Estimating
- Asset/Equipment Inventory
- Facility Operations
- Space assignment
- Maintenance/Repair
- Emergency response, etc.
- Higher-quality work
- New revenue and business opportunities

BIM offers the following in the major phases involved in the lifecycle of a building:

Design phase—design, schedule, and budget information
Construction phase—quality, schedule, and cost information
Management phase—performance, utilization, and financial information

The ability to keep this information up to date and accessible in an integrated digitalenvironment gives architects, engineers, builders, and owners a clear overall vision of theirprojects, as well as the ability to make better decisions faster—raising the quality andincreasing the profitability of projects.

Key BIM Software Packages

Though BIM was conceived as a single building information model for the entire construction industry, software developers came up with different BIM implementation packages as a single model was lacking when BIM was initiated. The International Alliance for Interoperability (IAI) led an international technical programme in 19 countries with the objective of defining a single building model as one authoritative semantic definition of building elements, their properties and interrelationships. This effort resulted in the Industry Foundation Class (IFC) model that has been endorsed as an ISO (International Standards Organization) standard. However, achieving interoperability across such a large and fragmented industry remains a challenge. The main leading providers of BIM solutions are:

Autodesk Architectural Desktop (ADT) ADT creates its building model as a loosely-coupled collection of drawings, each representing a portion of the complete BIM which are aggregated through various mechanisms to generate additional views of the building, reports, and schedules as though there was a single BIM at the center. Errors occur when the user manipulates the individual files outside the drawing management capabilities provided in ADT.

Autodesk REVIT With Revit, it is possible to coordinate every building element in one database, so users can immediately see the results of any design revisions made in the model, and reflect them in the associated views (drawings), as well as detect any coordination issues.
Bentley Systems More explicit origins in CAD.Bentley users can migrate work methods with origins in CAD easily. This is one of the software packages that supported IFC file formats from early development. But optimal levels of interoperability can be attained only when other Bentley products are being used on a project.
Graphisoft's ArchiCAD application creates a virtual building model so is one of many applications in a building's model rather than being the central clearing point that a single model is.
Nemetschek's AllPlan design allows third partydesign and analysis applications to interface with the building objects in the model.Its main market is German-speaking countries in Europe.

Challenges of BIM

Some problems with BIM include as highlighted by Howell and Batcheler include:

1. BIM systems create big and complex files hence the scalability and manageability of a fully loaded central BIM project database becomes a major challenge.
2. Sharing BIM information as drawing files. Users are defaulting back toexchanging documents (drawing files created as views of a building model) ratherthan sharing intelligent objects from the model.
3. The need for increasingly sophisticated data management at the building object level. Pioneering model server technology is only now being developed to helpaddress issues which surface when multi-disciplinary design teams try to adopt asingle BIM such as object versioning, object-level locking and real-time, multiuseraccess.
4. A contradiction in work process when using a single detailed BIM to try torepresent a number of the alternative design schemes under consideration. Whileparametrically defined building objects can quickly be recreated based on theinput of selected dimensions and properties, the need to maintain separate BIMmodels for different design alternatives is prohibitive
5. Every company on the project team cannot adopt one BIM system.Each company normally has its own preferred and trusted software applications for design and analysis. It isvery rare that a single technology is being used on any one building project between different companies and/or across all phases of the project lifecycle rather than being dependent on a single building model, project team members typically rely on a number of purpose-built models.

Adopting Building Information Modeling

The adoption of BIM in even advanced economies has not been universal or as rapid as expected because of some of the reasons highlighted above. Government nudging has often been needed to have progress. The General Services Administration (GSA) in the U.S.A made the use of BIM a requirement on all major projects receiving significant public funding in 2007. In Finland, the Senate Properties, a government owned organization which develops and manages implemented BIM Requirements in October 2007. Such a role has been played by governments in Northern Europe. Turning to Asia, In Singapore, the CORENET e-PLAN Check system (COnstruction Real Estate NETwork), launched by Singapore's Ministry of National Development) provides automated compliance checking against building codes for schemes designed using BIM. Adoption has been slower in the United Kingdom where there is no government policy promoting the adopting of BIM than elsewhere. (BIM was used at Heathrow T5 where it has been reported that it helped shave 5%-(£210million)- off project costs. Ten percent (10%) of Quantity Surveyors and three percent (3%) of Building Surveying Professional Group said they were using BIM regularly in a Royal Institue of Chartered Surveyors 2011 survey. A further 29% of both QSs and BSs have had some limited engagement with BIM. The driver of adoption is an increased awareness by owners to make decisions based upon building lifecycle costs versus initial capital cost.

Building Information Modelingand Cost Management in Building Construction Sector in Nigeria

The construction sector constitutes 2% of Nigeria's GDP. It is divided into the informal sector (people contracting builders to construct houses), the commercial sector (office accommodation in few cities such as Lagos and Abuja and residential estates by developers) and the public sector. Building Information Modeling has greater relevance for the commercial and public sub-sectors. It also has different implications for each sector as the issues regarding cost management are very different. CAD is still the prevalent means of modeling projects across all sectors.

In the commercial sector, the main players are banks and multinational companies, including oil firms. This is regarded as the more efficient sub-sector of the construction industry in Nigeria, with superior cost-management techniques compared to the public sector. The main contribution of BIM here is enhancing relationship between clients and building professionals as disputes sometimes arise over scope of work, modifications, over-runs and associated costs. Such disputes are more common between building professionals and sponsors of real estate projects. This is as a result of the more "entrepreneurial" culture of the industry; as opposed to large banks or multinational firms, real estate firms lack robust procurement departments with professionals experienced in documenting contracts. Many developers refuse to pay for quantity surveyors, expecting civil engineers to cost projects themselves based on "experience", greatly increasing the possibility for conflict on costs. The capacity of building professionals to acquire BIM tools and skills differ widely. Cost saving and contract-splitting practices are prevalent in the commercial sub-sector of Nigeria's construction industry, hence skilled but poorly resourced building contractors (who are sometimes just businessmen with no professional training in building) do get awarded contracts to execute sizable projects.

The public sector is considerably more formalized. Major contracts usually go to well-established building professionals. The main challenges regarding cost management here are poor budgeting and corruption. Projects are designed and contracts awarded on designs whose costs are not properly calculated. This often results in abandoned projects on which considerable resources have been committed and spent. An example is a Federal Secretariat Complex in the capital city, Abuja that was abandoned after it was discovered that building a vast underground car park was too expensive. Building projects in Nigerian are often a source of corruption. This often involves wild inflation of costs. The adoption of BIM will greatly enhance transparency, allowing different stakeholders (bidding contractors, parliament, civil society organizations etc) have a better idea of true project costs and the financial implications of variations.

Adopting Building Information Modeling In Nigeria

There move to adopt Building Information Modeling in Nigeria's private and public sector (client side) and amongst different building professionals (Architects, Quantity Surveyors, Civil Engineers etc) has been very slow. Architects have adopted but mainly for enhancing the visual quality of their presentation. This is unfortunate because of its enormous potentials to enhance efficiency, reduce disputes, save costs and curb corruption. The first step in promoting adoption will be to increase awareness of the technique, the tools employed and their benefits. Software vendors and training institutions have a role and commercial opportunity in promoting the awareness. Another critical step is for professional institutions such as the Nigerian Institute of Quantity Surveyors and the Nigerian Society of Engineers to organize training for their members and clients, including or perhaps especially public sector institutions. As this awareness grow, the construction press and other informed opinion such as analysts will join in the promotion of the critical cost management tool that the BIM represents.

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