BUILDING INFORMATION MODELLING (BIM): A SUMMARY OF SOME UK EXPERIENCES AS GUIDE TO ADOPTION IN NIGERIA

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ABSTRACT

Building information modelling (BIM) is a term that has been echoed around the world by researchers and practitioners alike. This is a new methodology (essentially electronic capture and focussed, timely distribution of relevant data) of project delivery that improves efficiency and quality of work. Although the word 'building' is used, BIM is equally applicable to civil engineering, utilities and infrastructure projects. Also, the word 'modelling' applies to the broad spectrum of process application not simply models produced by 3d software packages. The most important element in BIM is the 'information' and its beneficial capture and repeat usage. Every sector of the world economy is just looking for ways to produce more with fewer resources or making best use of the resources available. This paradigm shift has brought about the adoption of BIM in the construction industry. This paper will define BIM in simple terms; highlight its benefits and barriers; rationalise its workability, maturity levels and general ideas that it is based upon. The paper will also articulate some actual experiences from the UK at both the government and organisational level and the challenges overcome and some benefits achieved. Just like any other technology or methodology, BIM relies on collaboration for its successful implementation. This collaboration will create an avenue for construction teams to produce and make use of consistent unambiguous information, which will improve the overall efficiency in project delivery. For many people the question still remains. Will this be a solution to the all the problems in the industry? Or will it only solve particular problems? Just like every technology using it correctly will definitely yield benefits. Governments in many countries have recognised the usefulness of BIM and have intervened to make its implementation possible. As a developing country, Nigeria should not be far from making such efforts. There is need for construction industry to take proactive steps to overcome its problems. BIM implementation may not be a panacea to all the problems in the construction industry but it will surely make it better. Construction professionals may look at this idea with scepticism echoed, although it is now being overcome in countries adopting BIM. The earlier they realise that BIM will be the future of the industry the better.

Keywords: BIM, Collaboration, Efficiency, Benefits, Challenges

INTRODUCTION

In the construction industry, difference in understanding as a result of fragmented multi-disciplinary teams is not uncommon. With challenging economies, the industry has looked into the manufacturing industry for answers. The major contrast remains, with manufacturing it is usually the same repetitive product with the same project participants. On the other hand, the situation is different in construction. Buildings are distinct and teams are usually formed to execute a project with little history of working together in the past. This fragmented nature has brought about the inefficiencies that have plagued the building industry. Problems such as conflicts between multi-disciplinary teams, delays in projects, duplication of processes, cost and time overruns, to mention a few have overwhelmed the industry. These issues have led to the paradigm shift the construction industry is facing and BIM was borne to tackle some of these issues. The term BIM has been echoed worldwide and enthusiasts for change in the industry have welcomed it with open arms. The question still remains in the minds of professionals. What exactly is BIM? How is it defined? Are there standards and measures? Who will show me what to do, when and how? Are your interpretation, understanding, application and implementation the same as mine? The list goes on.

BIM finds its origin from computer-aided design (CAD) which has been around for some time. CAD designs later developed from 2D drawings to designs with 3D views. Succar et al. (2007) defines BIM as '*a set of interacting policies, processes and technologies producing a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle*'. From this definition we can see the three key components of BIM; People, Process and Technology. The experience from the UK has demonstrated that the relative importance of each of these components is approximately 70% people (you have to engage with them first), 20% process (the current processes have to be reviewed and understood so BIM can be introduced in a timely and effective way). 10% Technology (the temptation is to procure software to solve 'problems' that have not been properly defined). See Fig 1.

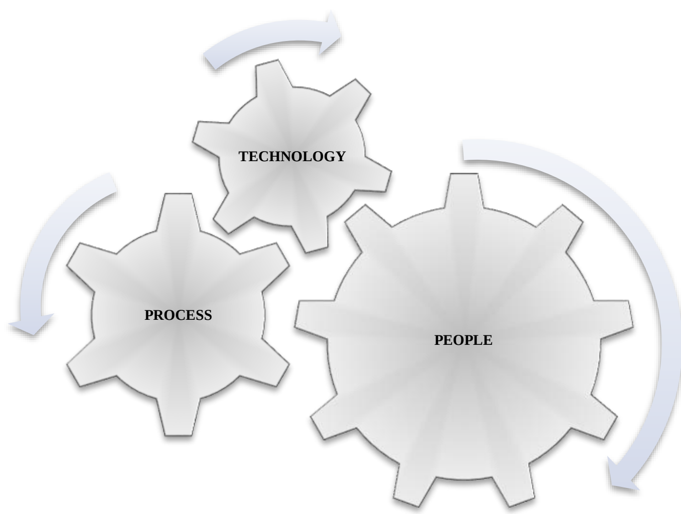

Figure 1: Key BIM Components

In recent years, Governments, practices and businesses have been getting up to speed with recent changes in the industry by adopting BIM, and by understanding it as a way of working rather that the use of technology for building design. The main concept of BIM is to have electronic data available in readily accessible format so that useful information can be derived from it at the right times in the process and re-used as required by the stakeholders. An easy to understand and a demonstrably good introduction to this is by the development of a virtual model during design, which can provide necessary information prior to construction i.e. to be able to have multiple views that display the vital parts of the building. As maturity and understanding of the information requirements develops, these models can either contain the data required (best kept light and agile or the model becomes over complicated), provides links and references to databases stored elsewhere like a graphic route map. See Fig 2.

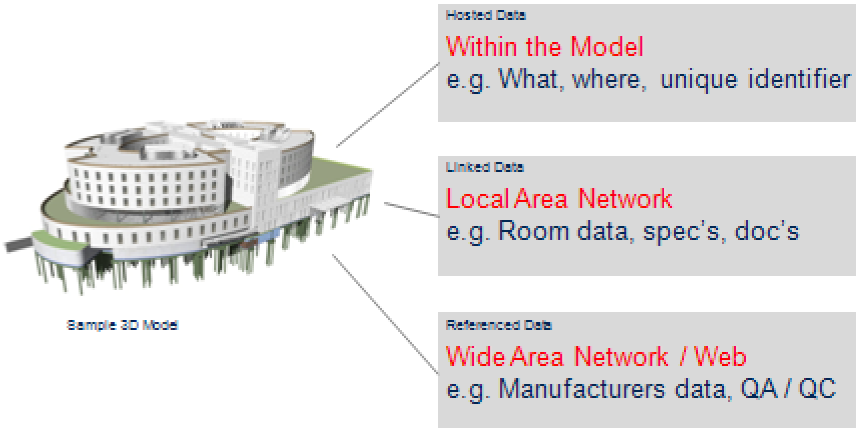

Figure 2: BIM Model as graphic route map

BIM has many levels of understanding as demonstrated by Jerningan (2007). There is the understanding of BIM at the small level (*'little BIM'*) and BIM at the higher level (*'big BIM'*). Fig 3 shows the maturity levels of BIM growing gradually from *little BIM* to *big BIM*.

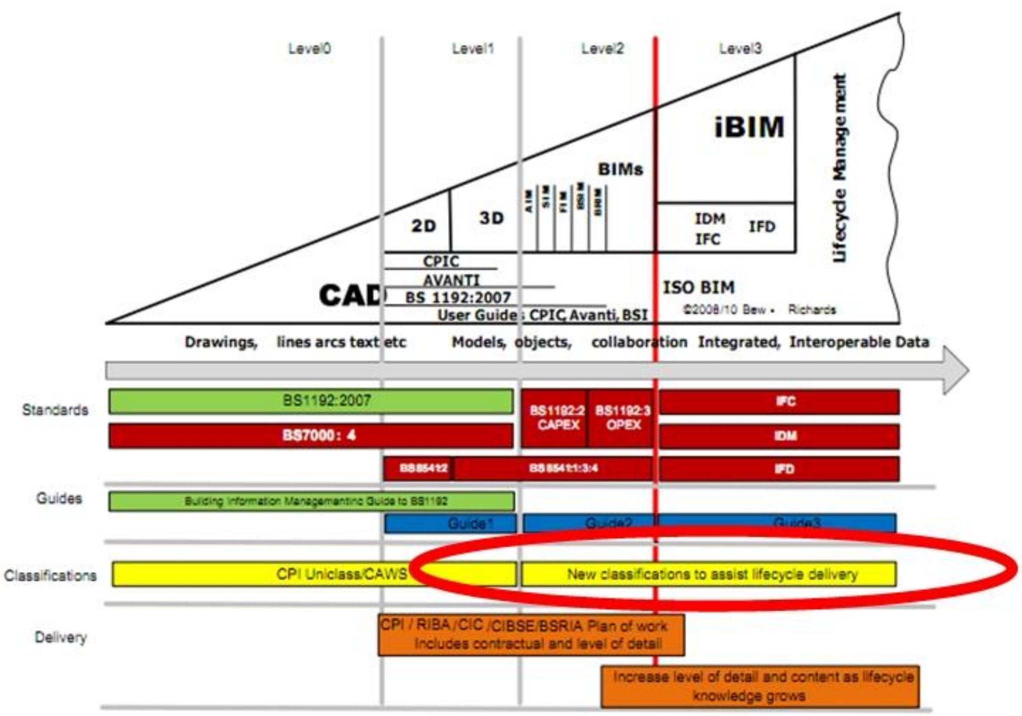

Figure 3: BIM Maturity Levels (Bew and Richards, 2008)

The development of BIM continues in stages as demonstrated by Bew and Richards (2008).

- **Level 0:**

This is the first stage where BIM is just a CAD tool. At this primal level, it is no more than a simple technology that uses 2D drawings to express building designs. This stage is usually uncoordinated and is hardly free from errors at every process (Gould, 2010).

- **Level 1:**

BIM moves on to the next level which partly involves modelling in 3D. This level can run in coordination with Avanti, CPIC and BS1192:2007 which are protocols that help in information management (Gould, 2010).

- **Level 2:**

The next level is where BIM is characterised by intelligent objects and information about the objects built into the model. The 2D and 3D models of earlier levels are developed further to create a digital model of the proposed facility. Also, objects can be cognitive and can be programmed to work relative to one another; this is known as parametric modelling. At this level of BIM development, waste and error can be cut by up to 50% (Bew and Richards, 2008; Gould, 2010).

- **Level 3:**

This stage is where BIM becomes fully interoperable and can be shared by all project participants in real time. The process of information sharing is done through information management protocols. At this stage of BIM development, BIM utilisation can increase profit and mitigate risk significantly (Bew and Richards, 2008; Gould 2010). This stage is still fairly abstract because it is yet to be fully implemented. BIM relies heavily on human input in the processes and technology because the credibility of final product is constantly dependent on the quality of information used at the initial stages. BIM Level 3 can be utilised to produce an intelligent model that is linked to the entire supply chain. This situation will then permit the ultimate objective of fully compatible and coordinated information exchange beyond construction so the estate can contribute to the broader service provision and information environment as illustrated in Fig 4.

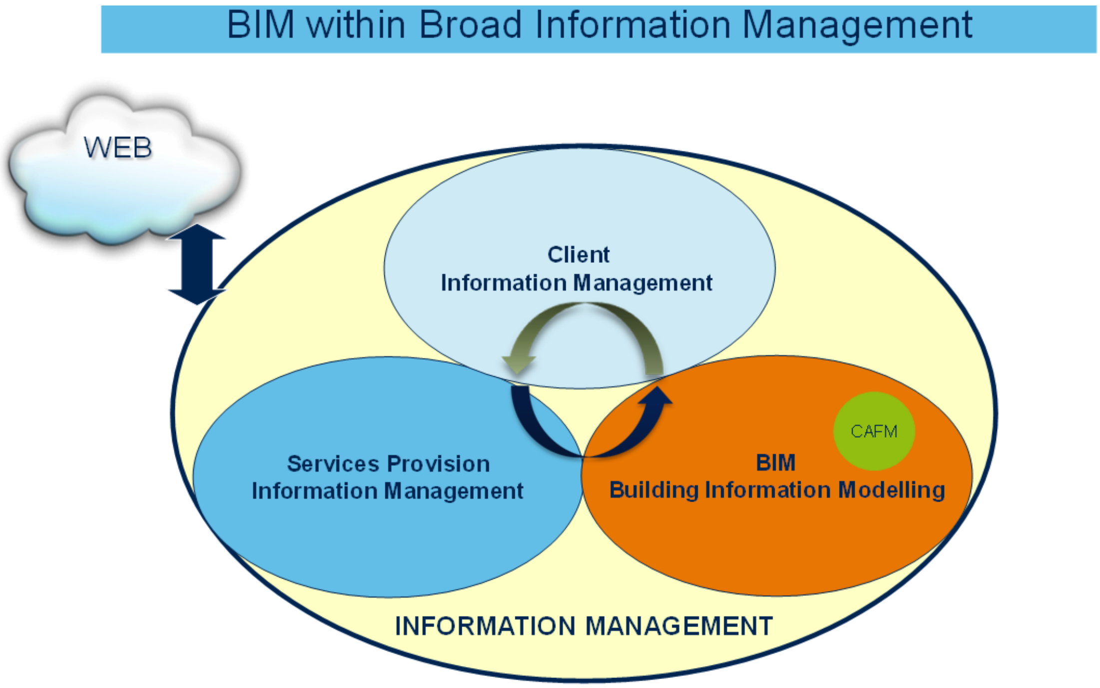

Figure 4: Broad information exchange environment

Currently BIM during project design and construction stages can be illustrated simply by the useful combination of a variety of electronic systems and databases as shown in Fig 5. As maturity develops the distinction between these separate systems is likely to reduce and potentially eventually disappear altogether.

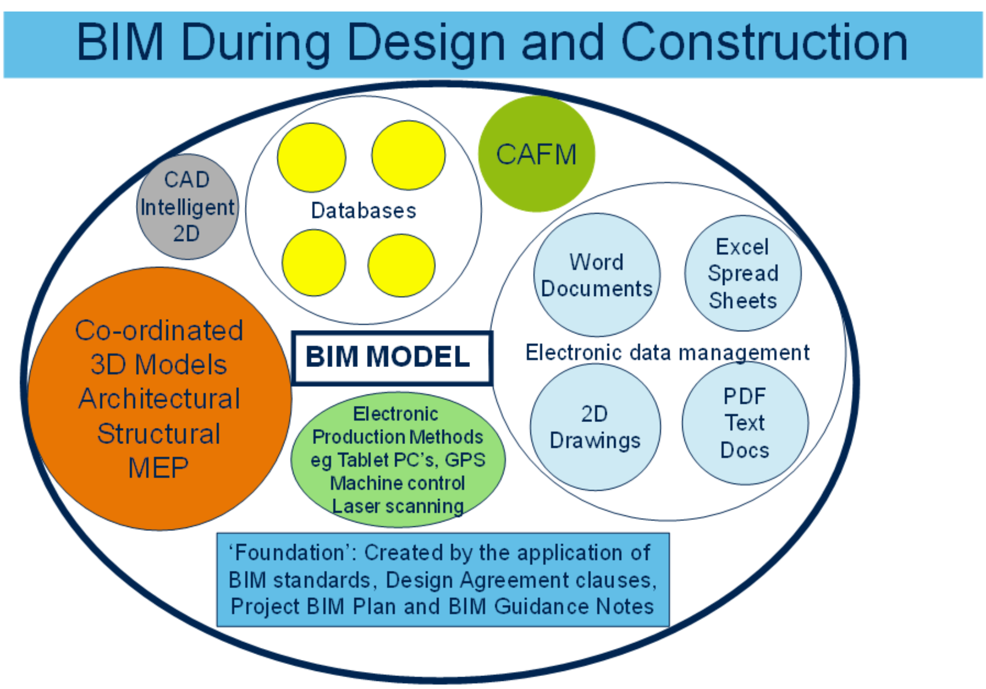

Figure 5: BIM during design and construction

Potential and Actual Benefits

The BIM platform has the capacity to solve communication issues in design and construction by making essential data available to all the participants in the project. One of the consequential benefits of engaging with the BIM process is the automatic improvement of the collaboration between stakeholders as they have to understand each others needs and constraints and how these depend upon the timing in the process. Key decisions and third party engagement have to be brought forward in the design process and the historical lateness of this has perpetuated the inefficiencies in the industry. BIM will likely help to improve the situation as the maturity and understanding develops. The availability of information helps promotes early decision making and eliminates disagreements and disputes, thereby, keeping projects on track. Also, BIM provides encompassing lifecycle support of a facility from inception to disposal by providing necessary maintenance information of all building elements in the facility. This means a reduction in design and management errors, and more efficiency through the value chain. The following are documented benefits of utilising BIM by SKANSKA.

- **On the M25:**
  - The use of Laser scanning has saved approximately £1000 per day in traffic management and improved the safety in live roadway surveying situations.
  - GPS machine control has reduced the requirement for timber profiling: the equivalent of five setting out engineers erecting and maintaining profiles.
  - Design alterations that would previously have take 2 weeks to turn around being expedited in four hours.
  - Using the models helped identify £3m savings in sheet piling requirements
- **At the Barts and Royal London Hospital:**
  - Exercises to extract quantities that would have taken 30 man days have been achieved in 4 hours.
  - Tablet PCs used on site connected to the room data sheets provided all the necessary information immediately. This improved the efficiency of the supply chain and site management and their ability to complete and verify the works to a high quality. Engagement with the client’s Independent Tester raised their confidence and enhanced their ability to sign-off the works. This meant the handover programme of thousands of rooms was shortened.
- **On Projects utilising BIM generally:**
  - Use of integrated design models in structured clash prevention workshops has identified ‘hard clashes’ where elements compete for the same space and also ‘soft clashes’ where components fit in space but do not have access space for initial installation or future maintenance. Consequential benefits of this process are where the client’s advisers are aware they have increased confidence which saves time and effort agreeing the designs.

This in turn permits the design experts to spend that time improving the overall quality of the design.

- Where time and effort has been expended by participants to articulate their BIM requirements in terms of format, content and location this has been rewarded by their ability to communicate with each other in a structured manner. This has also led to a greater mutual understanding, co-operation and improved collaboration. The outcome of this has been that the information required by others later in the whole process has been easily retrievable in the optimum format and quality. Previous experience used to be incomplete poor quality data, difficult to access.

▪ **Overseas experiences expanded in the UK:**

Benefits in the use of BIM have also been experienced on Skanska projects overseas. The mechanisms for delivering these benefits have been reproduced and implemented on UK projects that go through a bidding process. The creation of a BIM Steering Group on one particular project, to manage the BIM implementation process, has identified or established the following:

- The Facilities manager had mainly aspirational input, lacking practicality and requiring of further technical resource
- Issues to be raised in parallel meetings
- The need for an 'Information Management' Group
- Raised the profile of the BIM group internally and gave them a platform
- Established a vehicle for the broad Lessons Learned including and beyond BIM
- Provided a platform for the Facilities Manager and a channel for the client
- Focused the requirement for the Facilities Manager to articulate what they needed
- Raised the need to engage procurement and the supply chain to provide information and describe such in the works order
- Suggested the need for a responsibility matrix for the supply and management of data.
- Produced the simple definition for the format of data for the Facilities Manager and operation: 'Electronic', retrievable, accessible and searchable.
- Interfaces with the client and their need to identify some-one to manage the information and also to engage with the process
- 'Primed' the collaborative spirit for meetings subsequently convened

Further advantages of having a BIM group established to implement the practical detail and engage with the designers and construction staff has facilitated the following, which are traditionally difficult to demonstrate or implement effectively:

- Use of model to show secondary steelwork
- Large equipment movements demonstrated to Mechanical Electrical Plumbing (MEP) designer and the Client
- Practitioners recognising and expanding the use of models in undertaking their work
- 3D shaft images in MEP tender documents
- Regular 3D co-ordination meetings including the Facilities Manager
- Reviewable Design Data monitoring and engagement of the Client
- Approx 100,000 SEK saved by 'tidying' design (Pipe routes)
- Independent usage of model by logistics and planners
- The need to articulate requirements was established and then the actual articulation of those requirements
- Asset codes on 1200 MEP items as a pilot, rolled out to include all relevant assets

On several projects the use of BIM technology during the design, construction and handover stages has created better understanding and collaboration between the supply chain members. The examples are:

- The defining and inclusion of the FM requirements into the BIM databases
- The joint reviews and navigation of the BIM model and the adaptations of the design or construction and FM processes
- The co-operation and collaboration of the sub-contractors in the completion and handover process using the direct link to the BIM databases.

Current Status in an Exemplary Country (The UK)

In the UK, a number of leading construction and support organisations have begun to implement BIM and articulate the advantages and benefits. Skanska UK has been at the forefront of this adoption of BIM and embarked on the journey at the end of 2008 with the edict that all Skanska projects where there was influence over the design, would implement BIM. These industry successes helped support the UK Government decision, which was announced in the May 2011 Government Construction Strategy, that all publically procured projects would implement BIM. As a procurer of approximately 40% of the industry capacity the Government recognised that not only did the industry require to ‘push’ BIM but major clients also required to ‘pull’ BIM into the mainstream. The drive is to reduce the costs of the industry by 20% and BIM is seen as one of the primary drivers for this target. The target timescale for implementation has been defined as getting projects up to ‘level 2’ BIM by 2016.

The Government has not been prescriptive in the ‘how’ or the ‘what’ of implementation on any given project .The industry will provide the practical support and applications required and this will depend upon the current levels of maturity and understanding of stakeholders on any particular project. A great variety of solutions is therefore envisaged depending on the actual defined requirements for each project, the driver being higher quality and greater efficiency.

In order for there to be a recognisable structure to the government directive the Cabinet Office has appointed a BIM Task Group to oversee the implementation of BIM across government departments. A BIM Support Officer either has been, or will be appointed, to help introduce BIM to each government department. Examples are the Ministry of Justice, Department of Health and Highways Agency, although there are seventeen in all. The BIM Task Group has formulated a common structure for the roll out of BIM across the departments so there is a common message and structure to BIM definitions and implementation procedure. The BIM Support Officers meet regularly to exchange experiences and share the practical experiences of overcoming the challenges that each different department experiences, given the diverse nature of their projects and objectives.

Each department provides pilot and exemplar projects, called BIM early adopter projects (eap), that are implementing selected elements of BIM and monitoring and sharing the experiences. This knowledge will be transferred across to other projects. There are currently about 18 eap’s defined and the number is growing as the process progresses. The purpose of the BIM support officers is the assist the departments in creating their own BIM capability with their own staff as they become more and more familiar with the process.

Challenges and Opportunities (Maturity of Understanding/ Development within the Supply Chain, Clients, FM, Etc.)

Although there are many benefits in adopting BIM, there are significant challenges in the construction industry’s uptake of BIM. Technologies for design and project delivery in the construction industry will help reduce the constraints of BIM adoption. The use of coordinated building models in design, construction and eventually facilities management is the main objective of BIM, but there are limitations in the area of data exchange that make this process complicated. There are many opportunities of adopting BIM, some of them are;

- Competitive edge over rivals
- Not having to wait for perfect BIM for Benefits
- Better understanding of other’s needs/perspectives
- Enhanced Collaboration
- Un-envisaged advantages and usages
- Increasing benefits on subsequent projects
- Vehicle for lessons learned and POE
- Potential Differentiator
- Client Engagement

On the other hand, challenges of BIM implementation are almost directly related to human resistance to change. Construction professionals are comfortable with traditional methods of design and project delivery and are not willing to accept the benefits that BIM brings on board without much scepticism. Some of the challenges of BIM are:

- Timing in relation to projects: Awareness/Implementation process/Project Plan
- Common understanding of BIM
- How much BIM to Implement
- Levels of Details within the models
- Articulation of what is required
- Investment in the process
- Management of the process
- Legal issues

Practical Implementation Steps (Within Companies)

The adoption of BIM in individual companies will depend on several factors. This depends largely on business strategy and culture. Proper change management plans and strategic decisions will have to be undertaken to ensure implementation within individual companies. Top management have to identify the necessity for BIM adoption and to assess further the benefits BIM will bring onboard if implemented. Eastman et al. (2008) suggested a step by step guide for firms considering BIM implementation, they are;

- Appointing top level management to develop a roadmap for BIM adoption that encompasses every detail of the organisation. This plan should put in perspective the impact of change on the business processes and how this adoption will affect the firm's business strategy.

- Establishing Key managers that will be responsible for internal implementation of the BIM implementation plan. This team will work with key performance indicators based on cost, time and performance budgets.

- Set off using the BIM system in one or two pilot projects alongside the firm's traditional processes in producing documents. This parallel will help reveal the presence of lapses in implementation and will also improve the learning curve of the firm.

- Results and information obtained from previous stages should guide the adoption process at every stage. Investment in staff training should continue and senior management should be informed on the progress periodically.

- Broaden the use of BIM to new collaborative project teams that will utilise early integration and information sharing through the central building model.

- Continuously integrate BIM features in every aspect of the firm's business processes. These characteristics should be included in contractual documents with clients and business partners.

- At regular intervals, revise the BIM and BIM implementation process to incorporate the benefits realised so far and set new targets for performance on the basis of cost, time and performance budgets. BIM-facilitated changes should be extended to new parts of the business until full implementation is attained.

How Government Can Influence Adoption

Many governments all over the world have intervened in the construction industry with the aim of improving efficiency and saving public funds. Countries like the UK, USA, Finland, Norway, Denmark and Singapore have all made contributions with regards to BIM adoption in the construction industry. Countries in the middle-east are now making efforts in BIM adoption.

- In the UK, The Government has announced that the use of BIM will be compulsory on all UK Government projects by 2016. This regulation will encourage contractors working with the Public Sector to speed up the uptake of BIM.

- In the USA, there has been Government input in terms of adoption and interoperability challenges of BIM. The General Services Administration (GSA), of the US government has carried out some BIM projects in order to promote the use and application of Industry Foundation Class (IFC) in information exchange between applications (Eastman et al., 2008). BIM is also required in all projects procured by the GSA, US Army Corps and other government departments.
- In Finland, BIM is required by all Government projects managed by Senate Properties.
- In Norway, BIM is required by all Government projects managed by Statsbygg.
- In Denmark, BIM is required by various Government departments and BIM requirements are now forming part of the Danish law.
- In Singapore, the Government has made efforts to encourage BIM adoption by providing incentives in the form of subsidies to firms implementing BIM in their processes. Also, other innovative steps are the hosting of an e-submission system for compliance checking of BIM models.

As many clients are waking up to the potential BIM has for them, the Government in Nigeria can adopt various strategies with the aim of developing the construction industry further. This will eventually create more value for money in the long run. The following steps are suggested to for Government intervention.

i. Constitute a task force to investigate the construction industry and report on the pros and cons of the industry.

ii. Develop a working strategy to overcome the current challenges in the industry.

iii. Develop a BIM strategy including the role of Government in BIM adoption.

iv. Commission reports periodically to check on the progress and provide recommendations for future strategies.

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