A Framework for Developing a BIM Strategy

Bimal Kumar
School of Engineering and Built Environment
Glasgow Caledonian University

Graham Hayne,
School of Engineering and Built Environment
Glasgow Caledonian University

Abstract

Despite the availability and use of Building Information Modelling (BIM) technologies for well over a decade now, their wide scale adoption has been largely limited to the design stage with the benefits accruing largely locally to the design organisations by way of a more efficient design management process for dealing with clash detection and mitigation as well as other ensuing modifications to the design. The promised land of benefits from BIM has so far eluded the wider stakeholders at the project level and ultimately the end clients in any significant way. Only in recent times has there been a realisation within the industry that without proper processes, standards and contractual protocols in place for structured information management for all stakeholders, the BIM technologies, on their own, could probably never achieve the overall benefits for the end clients throughout the lifecycle of the assets as they potentially could. This paper argues that information management and exchange processes, standards and protocols underpinned and enabled by modern BIM technologies could indeed achieve considerable benefits to all stakeholders in a construction project. An overall framework for BIM-enabled asset delivery, operation and maintenance is proposed and its adoption by a large asset owner, National Health Service of Scotland, is described.

Keywords: Building Information Modelling, Information Exchange, Design, Collaboration, Construction

1. Introduction and Background

BIM has been a major topic of interest for the construction industry around the world in recent years. There are several high profile examples of BIM-driven project delivery (Dossick and Neff, 2010; Sebastian, 2011; Porwal and Hewage, 2013; Barlish and Sullivan, 2010) that different organisations have claimed to have delivered over the recent past. At the same time, there has been a considerable amount of misunderstanding about what exactly a BIM-driven project actually implies. The vast majority of practitioners appear to take the usage of BIM software in some aspects of the lifecycle of built asset procurement for it to qualify to be a BIM-enabled asset delivery. That seems to be the prevailing wisdom and understanding at the time of writing this paper. Lately, it has been pointed out by several organisations and experts that whilst the 'lonely' use of BIM technologies does accrue benefits largely to the organisation using them it does not necessarily benefit the project as a whole and the end client organisation. To achieve benefits at the project level and to the end clients over the entire lifecycle of the built asset, *Collaborative BIM* needs to be implemented with appropriate processes, information exchange standards and contractual protocols in place. Besides, the cost of lack of interoperability between systems which is a key requirement for effective collaboration has been quantified in the USA (Gallaher et al., 2004). This paper proposes a framework for developing a Collaborative BIM strategy and discusses its implications by reporting on its implementation in a large asset owning organisation in the UK. The implications of Collaborative BIM are far-reaching and could potentially alter the relationships between the key stakeholders profoundly (Crotty, 2012; Kumar, 2013 and 2015; Bryde et al., 2013; Fox and Hietanen, 2007). There are also potential implications for the government bodies as well as the society at large. As increased amounts of digital information get captured by utilising a collaborative BIM approach, several hitherto unknown inferences could be drawn about the performance of built assets including their users' behaviour patterns giving rise to several policy level and strategic decisions about their procurement, operation and maintenance and future capital planning processes. It is, therefore, no surprise that governments around the world (Cheng and Qiqi, 2015) are actively adapting their procurement processes to suit a Collaborative BIM-enabled approach. In the UK[1], an entire set of processes and standards for information exchanges have been made mandatory in all publicly procured projects from 2016 (BIS, 2011). This mandate is being facilitated by a whole suite of guidance and standard documents (CIC, 2013a; CIC, 2013b; CIC, 2013c; CIC, 2014; CIC, 2015) that every project must comply with.

2. Research Methodology

As discussed in section 4 later, the methodology adopted in this work was one of iterative workshops with relevant stakeholders with a view to first developing the process maps (section 4.1). There were some four workshops organised each one of which focussed on certain aspects of the existing process map for asset procurement within NHS Scotland and how they could be mapped on a new set of BIM-based processes. Once the process map was in place, several guidance documents and templates were developed covering the different

[1] In Scotland, a similar mandate comes into effect in April 2017

stages of the process map. These documents were also developed and improved through iterative feedbacks and consultations within the key and relevant stakeholders of all the fourteen health boards of NHS Scotland. It can, therefore, be concluded that the research methodology used in this work was qualitative action research. Action research generally involves "a disciplined process of inquiry conducted by and for those taking the action. The primary reason for engaging in action research is to assist the "actor" in improving and/or refining his or her actions" (Sagor, 2016). Action research is also defined as "active participation by the researcher in the process under study in order to identify, promote and evaluate problems and solutions" (Fellowes and Liu, 2008). The key steps in the adopted research methodology can be summarised as:

- Iterative Focussed Workshops (Group interviews)
- Validation through focussed workshops and feedback loop
- Generalisation through further feedback through focussed workshops

3. Models for BIM Adoption

There are several models proposed for BIM adoption and literature is replete with competing ideas. Based on work done by Everett Rogers (2003), Succar and Kassem (2015) have distinguished adoption from diffusion by suggesting that adoption deals with a single organisation whilst diffusion relates to the entire industry, sector or even a whole country. Moore (2014) wrote a seminal book aimed primarily at marketing and sales professionals on how a particular technology transitions from being just a desirable gadget to a popular one capturing increasing share of markets they operate in. He calls this *crossing the chasm*. Moore proposes that the early adopters of a product are typically the *enthusiasts* and the *visionaries* whereas the majority *buyers* at a much later stage are the *pragmatists.*

In the context of any such innovation or major change in the construction industry, one should first consider its nature and key characteristics and how it operates. The construction industry is a project (rather than product) based industry and possesses quite unique set of characteristics. Relatively low market share by any single organisation and arguably severe fragmentation in the industry are two such characteristics that arguably raise the industry's proclivity to poor innovation and profitability records. The most important implication of all this is that there is potentially only one way to affect any major changes (e.g. innovation) in this industry. The only way any such change could be implemented in this industry is if a powerful client body *forces* it. It is well established that in most countries the Government, being the single largest client group, happens to be the most powerful client of this industry. Therefore, it is reasonable to argue that the adoption (or *diffusion*) of BIM around the world is driven predominantly by a similar drive by the respective governments (some are more effective than others).

3.1 What is BIM?

BIM has been defined by several people emphasising on the different aspects of its implementation and potential benefits. For example, Eastman et al. (2013) have defined BIM as a *modelling technology* and *associated set of processes* to produce, communicate and analyse building models. These building models are characterised by building components that are represented with

intelligent digital representations that 'know' what they are and can be associated with computable graphic and data attributes and parametric rules. Royal Institute of Chartered Surveyors (RICS) describe the fundamentals of BIM as '... a common single and co-ordinated source of structured information...' (RICS, 2016). National BIM Standards-United States definition (NBIMS, 2016): "*A BIM is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward.*"

4. Elements of a BIM-based Asset Procurement Strategy

First of all, in any BIM adoption strategy, the overall purpose of a BIM strategy needs to be elucidated. It is suggested here that any such strategy is intended to ensure the creation of a *digitised information management process* which all stakeholders and people working on projects should follow to maintain consistency and facilitate collaborative working, which will, in turn, reduce waste and non-conformances. To that end, any such strategy should encapsulate the overall BIM-enabled project process as indicated in the schematic below:

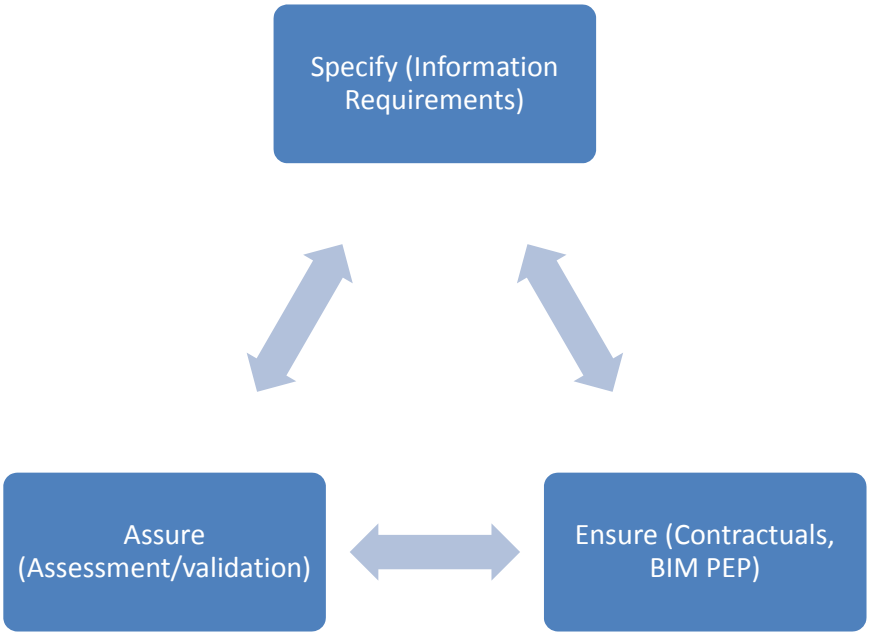

Figure 1. The schematic overall BIM-based Asset Procurement Process

This section describes the different elements of the BIM-based asset procurement strategy. First and foremost, a process map needs to be developed which aligns with a typical information delivery lifecycle (PAS1192: Part2: 2013). As mentioned earlier in section on research methodology, this is accomplished through a series of iterative focussed workshops and feedback loops which takes the existing asset procurement process and maps its keys stages with the corresponding stages of a BIM-based version of the process. Once this is in place, associated guidance documents and templates need to be developed aligned with the BIM-based process map for specifying the information requirements and ensuring and assuring (as shown above) their delivery by the project team.

4.1 Process Mapping

To summarise the whole process of implementing a BIM-enabled asset life cycle, this section presents a high-level workflow that brings together all the ideas discussed earlier in this paper. The process starts with the definition of a need for either a new asset or refurbishment or enhancement of an existing asset. In the case of a new asset, the process starts off with a clean sheet consisting of a set of requirements that the asset owner (the employer) might have. This is what would be compiled together in an Information Requirements (IR) document. Based on the IRs, a project procurement process may be initiated, which will be driven by the IR document in terms of which procurement route to adopt as well as informing the tender documents. The tenders could well be single or multistage ones, but such details are omitted here because the focus is to outline the overall workflow. The tenders received will be based on the IRs and any protocols that the project may follow. At this stage, the information may well be at a higher level but may include BEP (BIM Execution Plan) documents including the tenderers' proposed approach as well as their capability and competence in relation to BIM. This will then be followed by the awards of the contract after various negotiations and clarifications. At this stage, a more comprehensive BEP document will be prepared, agreed and signed off by all stakeholders of the project. In addition to the BEP document, an IDP (Information Delivery Plan) will be prepared. At this stage, the PIM (Project Information Model) starts taking shape, consisting of essentially graphical (building information models), non-graphical and other documents that will include populated templates from the BEP and other documents as stipulated in the IR document. At the end of the construction phase, the completed PIM essentially becomes the AIM (Asset Information Model), which is handed over to the asset management and facilities management group. In the case of a refurbishment or enhancement project for an existing asset, the AIM should already be in place for the asset in question and that becomes the starting point when specifying the need for the project, which is then followed by the same steps mentioned above for a new build project.

At the start of the process for developing a BIM Implementation strategy, this BIM workflow, must be mapped onto the existing project/asset procurement process in the organisation. This is typically done through a number of feedback workshops where the practitioners of the existing processes will brainstorm each of its stage and work out the appropriate BIM workflow stages that they naturally map onto. An example of such a process mapping exercise is discussed in section 5.3 for developing the BIM process map for NHS Scotland.

4.2 Information Requirements Specification

As mentioned earlier, once the process map has been developed, the first document that needs to be developed is the information requirements templates that will mainly answer the following question,

- What information does the client organisation need to operate and maintain the asset after handover?
- What standard formats and schemas must the supplied information comply with?

- What levels of detail should the supplied information adhere to?

These questions imply that the asset and facilities management teams need to contribute in a significant way to this stage when the information requirements are being specified. These requirements will be driven, to a large extent, by the input requirements for the CAFM (Computer-aided Facilities Management) and EAMS (Electronic Asset Management System) currently in use by the client (asset owner/employer) organisation. To facilitate and streamline the process of specifying the requirements, a standard template can be developed which can be adapted for specific projects based on the specific requirements of the asset in question. In the UK, this template (or document once it is fully developed for a particular project) is called the EIR (Employer's Information Requirements). It must be stressed that the importance of EIR document cannot be over-emphasised as everything else hangs off this document.

4.3 BIM Protocols/Contracts

The primary objective of the protocol is to enable the production of the models at defined stages of a project. The protocol should incorporate provisions which support the production of deliverables for 'data drops' at defined project stages. The protocol also should provide for the appointment of an 'Information Manager'. A further objective of the protocol is that its use will support the adoption of effective collaborative working practices in Project Teams. Finally, it should deal with the intellectual property rights (IPR) in relation to the production, ownership and usage of the models by different stakeholders in a project. Different countries have their own approach to dealing with these issues. In the UK, the ownership of the models lies with whoever produces it but the other stakeholders essentially get a license to use the models in relation to any project-related activities.

4.4 BIM Project Execution Plans

Similar to a typical Project execution Plan (PEP) in a traditional project delivery process, every BIM-enabled project should have a BIM PEP document agreed and signed off by all stakeholders, right at the start of the project. Contractually, this document becomes an addendum to the contract documents in the UK. Therefore, every stakeholder of a project is contractually bound to comply with this document. There are several reasons why a document such as a BIM PEP is essential to ensure that all stakeholders in a project deliver what is expected of them. Introducing BIM in a project usually means bringing in new processes, particularly in terms of information management. In order to successfully manage information in a project, everyone involved in the project needs to sign up to processes and standards in advance of execution of the project. This can only be achieved by careful advance planning and documenting all processes mapped on to the responsible parties alongside the different stages of the project. Therefore, whenever there is a lack of clarity, dispute or confusion about any aspect of delivery of information throughout the life cycle of the project, the BIM PEP is the document that the project team should rely on for resolution. It is, therefore, not hard to imagine the crucial and important role that this document can play in successful project delivery. Although the BIM PEP is supposed to be provided by the supply chain in response to the IRs addressing the question, "How they will deliver the

information specified in the IRs?", it is recommended that in the interest of consistency of formats, the client/employer organisation should have its own BIM PEP template which the supply chain should fill in as required.

5. An Example of Implementation of the BIM Strategy – NHS Scotland

In response to the UK government's mandate for BIM-driven project delivery from 2016, National Health Service of Scotland, decided to develop a BIM strategy for procurement of all its assets. NHS Scotland is one of the largest asset owners in the UK with more than 2,000 assets under operation and management. These assets are predominantly healthcare facilities some of which are highly complex in terms of their size and functionalities. Their last major capital project was the Queen Elizabeth Hospital in Glasgow with 1677 beds and an estimated value of circa. £850 million and is Scotland's largest ever publicly funded NHS construction project.

5.1 NHS Scotland Procurement Routes

NHS Scotland use a number of different procurement routes depending on various factors. Some of the key ones are briefly described below.

Frameworks 2

Frameworks Scotland 2 is a strategic partnering approach to the procurement of capital schemes across NHS Scotland. It is a framework for the whole of Scotland based on a single point deliverer (Principal Supply Chain Partner or PSCP) model offering a one stop shop for the delivery of design and construction on projects via an integrated supply chain. Frameworks Scotland 2 is the successor to and builds on the success of Frameworks Scotland (SCIM, 2015).

NPD

The Non-Profit Distributing (NPD) programme was developed as an alternative to, and has since superseded the traditional Private Finance Initiative (PFI) model in Scotland and is being used to fund projects in three main sectors – Further Education, Health and Transport.

5.2 RIBA Plan of Works 2013

In 2013, the Royal Institution of British Architects (RIBA) published a newly modified Plan of Work (PoW). This was arguably in response to the ascendancy of BIM-based asset delivery in the UK and elsewhere in the world. The RIBA PoW (RIBA PoW, 2013) has been by far the most popular process map used by the construction industry in the UK and several other countries. The PoW organises the entire process of concept, briefing, design, construction and operation and maintenance into a number of discrete stages. The 2013 PoW stresses the predominance of the whole project team and the importance of the entire team's early involvement in the whole process.

5.3 NHS Scotland BIM-based Process Mapping

As mentioned before, the first step in the development of the BIM strategy is the mapping of the existing procurement processes to a BIM-based one. Through a number of focussed workshops which included representatives from the design, capital planning, projects and strategy groups of all the fourteen health boards in Scotland, the mapping process was carried out. An initial draft set of process mapping was then circulated and feedbacks sought from all the boards. After several iterations, the final BIM-based process map was arrived at as shown below in figure 3. Figure 2 shows the existing process stages which includes the RIBA 2013 work stages and the SCIM stages that NHS Scotland use on traditional projects. Figure 4 shows a further elaboration of the developed process maps by specifying exactly what kinds of information need to be delivered at the different stages or 'data drop points' of the process.

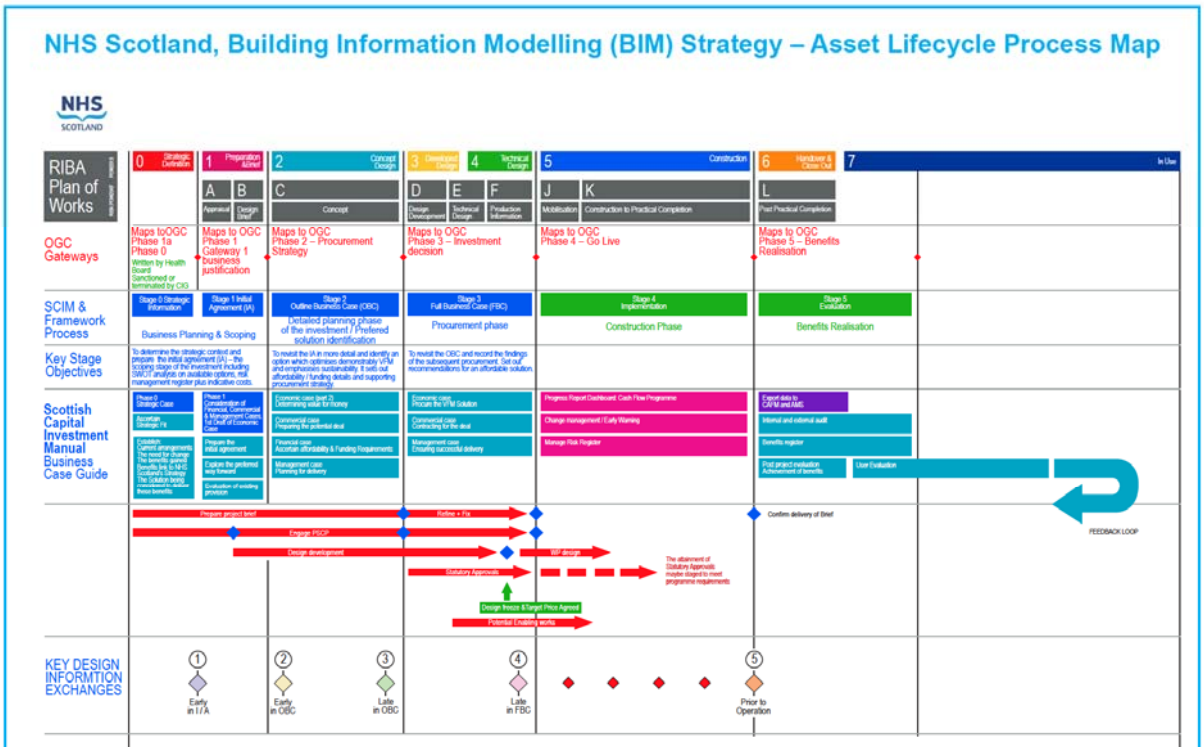

Figure 2. Existing Process Maps

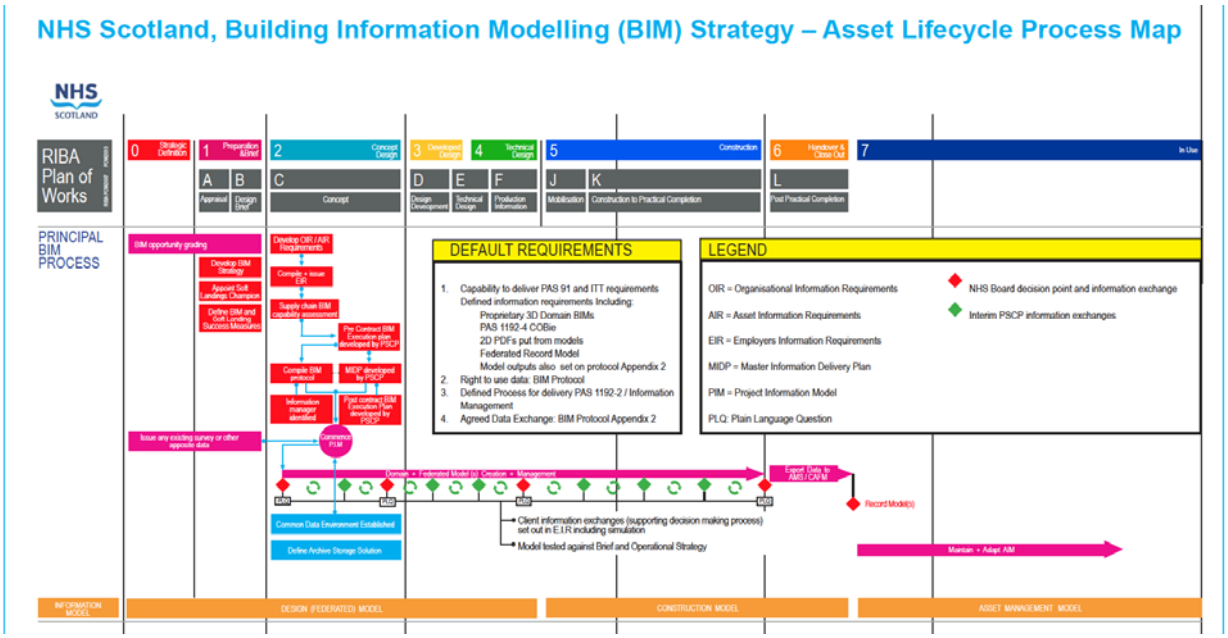

Figure 3: NHS Scotland BIM Processes Mapped on to Existing Processes

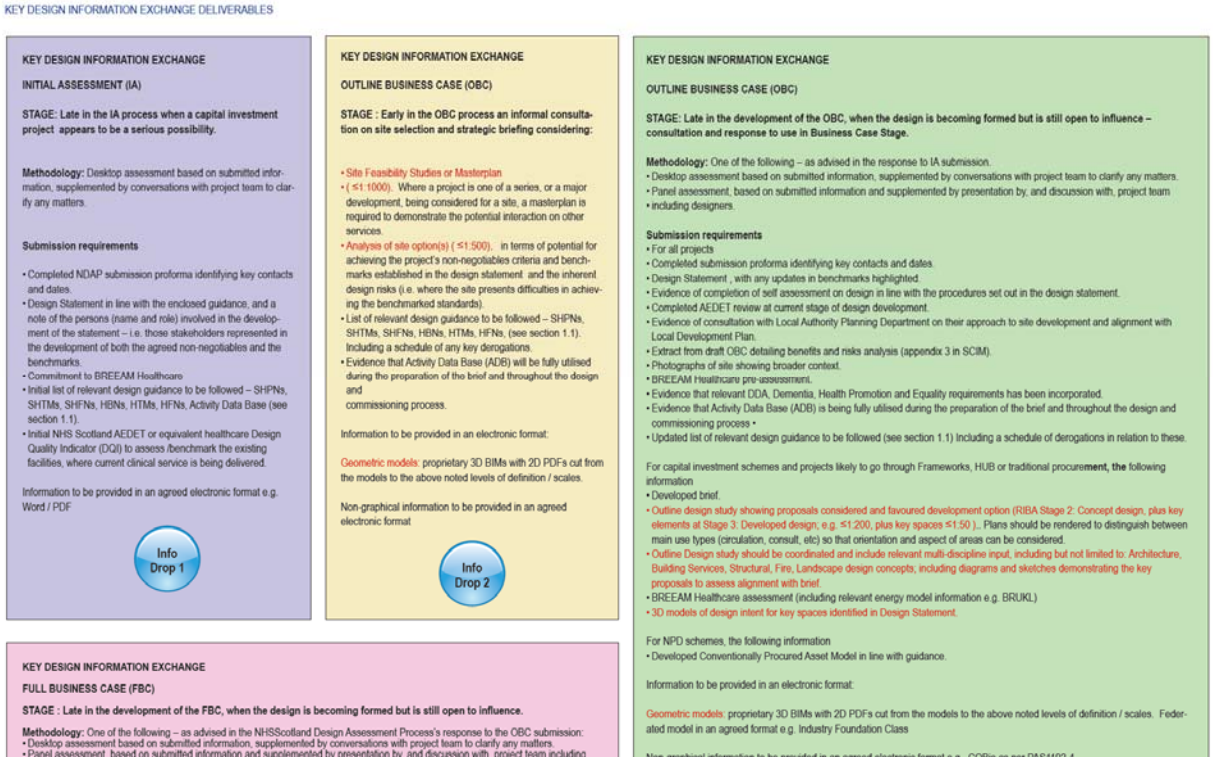

Figure 4: A snapshot of some of the NHS Scotland BIM Process Data Drops

NHS SCOTLAND

[INSERT PROJECT TITLE]
EMPLOYERS INFORMATION REQUIREMENTS (EIR)

NHS Scotland Drop 3

Information to be delivered prior to the end of RIBA Plan of Work Stage C

(to be edited in concert with individual project requirements)

(RIBA POW13 – Stage 2)

NHS Scotland Drop 3	Description	Model	2D PDF Drawings	2D DWG Drawings	COBie UK	Digital Documentation	Level of definition
Overall form and content							
Space planning	Confirmed zoning. Confirmed scale of spaces and of the building as a whole that the PSCP (OR MAIN CONTACTOR) Proposes. Confirmed adjacencies and circulation pattern	✓			✓	✓	2
Site and context	Relationship to adjacent buildings and external uses/circulation. Proposed levels.	✓			✓	✓	2
External form and appearance	Proposed approach	✓			✓	✓	2
Building and site sections	Relationship to adjacent buildings and external uses/circulation. Proposed levels	✓			✓	✓	2
Internal layouts	Proposals for internal layout of key spaces	✓			✓	✓	2
Design strategies							
Fire	Compliant summary of strategy that will be adopted for this building	✓			✓	✓	2
Physical security	Compliant summary of	✓			✓	✓	2

Figure 5: A section of NHS Scotland Employer's information requirements Template

Figure 5 above gives a very brief snapshot of the key EIR template that has been developed for NHS Scotland to be used on all projects. It is not possible to give any detailed description of the whole document here but suffice it to mention that the whole idea is that this template essentially specifies the information requirements of the NHS Scotland derived largely from the CAFM and EAMS systems in use by the different health boards. The PSCP is then invited to submit the BEP based on the IRs specified using this template. Once the BEP is accepted, there is an IDP template developed for NHS Scotland which is the PSCP also provides. At this point, the EIRs, BEP and the IDP are in place and the project is effectively ready to proceed to the implantation/construction stage. Beyond this, at every data drop point, the delivered data are assessed against the expected data for that stage using the data drop map shown in figure 4. Finally, at the handover stage NHS Scotland will not only be handed over the physical asset (hospital etc.) but also a digital information base which can seamlessly be transferred to the CAFM and EAMS systems.

The process maps developed and the EIR templates described above are now being used on some pilot projects by NHS Scotland. The BIM protocols developed are also being added to the existing contracts for these projects. The assessment of the benefits from this new approach will be carried out in due course using a set of BIM-based Key Performance Indicators (KPIs). The description of the KPIs and their use in assessing the benefits is beyond the scope of this paper. The early anecdotal indications are positive in that there appears to be a clear decrease in RFIs and change requests and consequently the costs associated with them.

6. Summary and Conclusions

A BIM-based asset procurement strategy requires a number of discrete steps to be implemented. A comprehensive process mapping exercise needs to be undertaken to link the existing processes to a BIM-based workflow. Subsequently, a number of key guidance documents and templates need to be developed, most notably the Information Requirements Specifications template, BIM protocols and the BIM project execution plan templates. The BIM PEP template is primarily to be used by the supply chain to articulate how they will deliver the information requirements specified in the IR specifications. But, it is recommended that the if the client/employer organisation provides a standard template based on its own requirements, it will provide a standard response from every member of the supply chain rather than a mix of different, often unacceptable, formats. This paper has presented the implementation of such a BIM strategy for the NHS of Scotland. The most challenging aspects of making the transition to BIM-based asset procurement are related to a change in mind sets and culture of organisation than simply a move to a different technology as the key changes relate to different processes for procurement and not simply the use of a different technology.

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