BUILDING INFORMATION MODELLING (BIM), UTILISED DURING THE DESIGN AND CONSTRUCTION PHASE OF A PROJECT HAS THE POTENTIAL TO CREATE A VALUABLE ASSET IN ITS OWN RIGHT ('BIMASSET') AT HANDOVER THAT IN TURN ENHANCES THE VALUE OF THE DEVELOPMENT

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KEYWORDS: BIM, Asset, Data, Value, Evidence.

ABSTRACT:

BIM currently appears to be seen primarily as a vehicle to deliver efficiencies within the design and construction phases of built assets lifespan.

In this paper, we postulate that the amalgamation of the data and its capture in the BIM technologies, models and associated links and references has the potential to create an effective asset in its own right. The 'BIMAsset', like any other asset, will require ongoing observation and maintenance throughout the physical asset's life to extract maximum value from it. A substantial part of this value is likely to be the enhanced value of the development because of the accessibility, accuracy and currency of the data relating to the project. This will be of probable benefit to all owners and maintainers of constructed assets in their use, sale and even future demolition.

1.0   INTRODUCTION

The adoption of BIM in the construction industry has revolutionised the current and future roles of professionals by bringing about a more productive and collaborative workflow in the project delivery process.

BIM as a term commonly refers to designing, constructing and managing buildings but its major strength lies in its ability to maintain a digital database, which can be used together with other software in order to run simulations and deliver information to professionals in the industry (Sah and Cory, 2008). According to Eastman *et al.* (2011), BIM is a modelling technology and associated set of processes used to produce, communicate and analyse building models. BIM can accurately capture the entire geometry and characteristics of a building in a single building model. BIM is generally seen as the technologies used to deliver projects efficiently, but as building professionals we need to look beyond that point. There is need for the industry to cast a shining light on the deliverables of the BIM process. That is to recognise the value of 'BIMAsset', 'BIM Model' and the 'Building Asset'. This paper will focus mainly on the 'BIMAsset'.

One of the presumed benefits of the 'BIMAsset' is that it will enable vendors to reinforce to investors the security of their investment, and that those projects which demonstrate these attributes will either attract a premium or reduced sale costs. That is, by reducing the need for repeat surveys, due diligence and compliance exercises based on perhaps scanty demonstrable evidence and substantiated detail as experienced in the past, by having up to date accurate data.

From our participation on projects, in the capacity of Client/Owner Developer through Design and Construction through to divestment and the inclusion of retained assets within our projects. We have established the notion that the 'BIMAsset' might have a life which will progress through the Design and Construction into the Operation and Maintenance phases through changes of ownership, refurbishment and final disposal.

One of the perceived challenges is the potential degradation of the data, through the life of the project and constructed facility. For example, if the BIM dataset is frozen as the building enters its operation phase then the accuracy and currency of the data will degrade at the rate the assets are replaced and renewed. This can be illustrated graphically and the confidence in the data set will rapidly diminish to a point where the 'BIM investment' is lost. This possible risk can be mitigated by ensuring the currency of the BIM databases are retained by recording the evolution the constructed facility caused by changes and updates. This is likely to be achieved by links through the Computer Aided Facilities Management (CAFM) system which could retain an historical record of events as well as the detailed changes similar to the way the mainframe has supported the IT industry.

This purpose of this paper is to propose the hypothesis of the existence of the 'BIMAsset', explore its composition, value, compromises, and limitations.

1.1   HYPOTHESIS

H1: In this paper, we postulate that the amalgamation of the data and its capture in the BIM technologies, models and associated links and references (models will include design models which may be combined or linked; and datasets which may consist of databases which are addressable in either direction) has the potential to create an effective asset in its own right called the 'BIMAsset'.
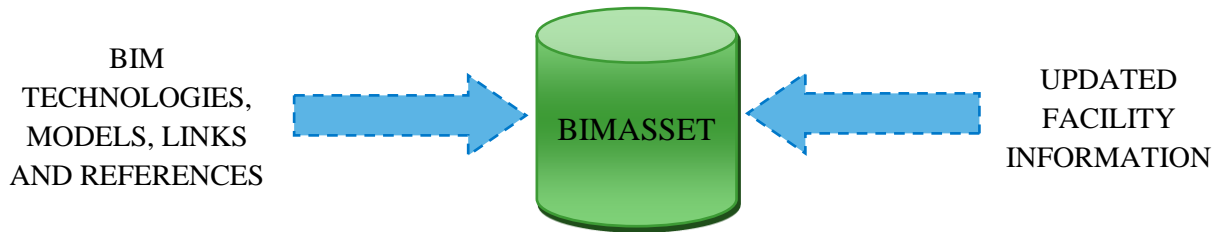

Figure 1: H1

H2: Also, we postulate that the deterioration in the confidence of the 'BIMAsset' data is directly proportional to the rate at which assets are replaced if the replacements are not captured within the BIM environment over the entire lifecycle of a facility.
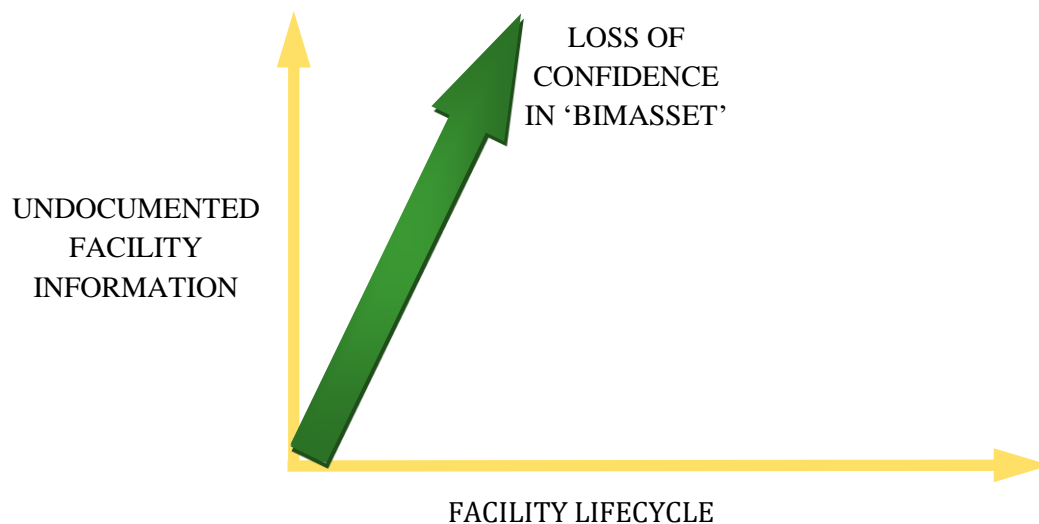

Figure 2: H2

1.2   ASSUMPTIONS

The assumption made in this paper is as follows:

i.   All elements replaced over the entire lifecycle are not of equal impact/relevance to the performance of the facility.

1.3   METHODOLOGY

The aim of this paper is to identify the potential value of the 'BIMAsset', its benefits, composition and limitation. This study achieves the aim by way of qualitative research methods. This was done by careful research of previous project records, documented professional experiences and other literary sources.

The study starts by proposing a hypothesis that the 'BIMAsset' can be an asset in its own right. To establish this proposition, we recognised the 'BIMAsset' as an informational database of the 'Building Asset' and we compared it to similar systems in other industries. For the 'BIMAsset' to be an asset in its own right, it must have a significant value. Benefits such as reduction in the cost of surveys, confidence in the dataset were investigated.

In order to establish H_2, clients were investigated to determine the rate at which undocumented replacements affect confidence levels. This is because, as an asset, confidence is vital and without proper management and frequent updating, the 'BIMAsset' dataset will be worthless. Hence, not worth the investment.

Interviews of clients in this study have indicated that:

- This relationship is not directly proportional and is dependent upon the build asset component type and the level of deviation from a very high level of demonstrable accuracy before confidence falls away; the views expressed are that only a small deviation from high accuracy levels leads to a significant fall in confidence.

- That all assets are not of equal value and that the significance of the component wanes and waxes dependent upon the point in the built assets lifecycle

The hypotheses were validated through project records, literature sources and declarations from professional in the industry in terms of potential savings.

2.0   BIM AND 'BIMASSET'

BIM

BIM is an emerging procedural, technological, strategy approach in addressing the inefficiencies of the AEC industry (Succar, 2005; Eastman *et al.*, 2011). BIM encompasses a series of interrelating techniques and technologies which generates a methodology for managing project design and data in a digital format throughout the lifecycle of a facility (Succar *et al.*, 2007). BIM is not a replacement for previous design technologies like CAD, but a succession from such technologies. BIM enables construction professionals to make informative cost-time-benefit assessment on the entire project lifecycle by working collaboratively on a model (Thomson and Miner, 2007).

BIMASSET

In this paper we define the 'BIMAsset' as the combination of BIM technologies together with the updated facility information, models, associated links and references in a an interoperable structure to be handed over to clients at the point of practical completion or at the point of sale. The 'Building Model' consists of objects contained in a facility in a digital database (Eastman *et al.*, 2011). On the other hand, we define the 'Building Asset' as the psychical tangible structure constructed and handed over to clients by constructors so as to fulfil their contractual responsibilities.

2.1   WHY DO WE NEED TO RECOGNISE THE 'BIMASSET'?

The overall concept BIM is having a knowledge based repository which provides a basis for reliable decision making throughout the entire lifecycle of a facility (Zhang *et al.*, 2009). The major property of BIM is its ability to hold the entire database of a facility in a single entity. This paper mainly highlights on one deliverable of the BIM process, the 'BIMAsset', which if fully utilised will have the potential to answer questions like:

    i.   What are the lifecycle costs of certain elements of the system?
    ii.   Which elements have shorter lifecycles?
    iii.   What is the economic performance of the facility at the end of its lifecycle?
    iv.   Are all the statutory compliances achieved?

From interviewing participants within the construction industry from the Building surveying profession the following constraints have been identified and that the value of BIM Data is dependent upon:

- Confidence in the accuracy of the records that they truly represent the 'As Built' asset.
- The extent that they represent a comprehensive set of data of the built asset.
- That the design quality has been delivered by the construction activities.
- That the records have captured the operational changes to the assets to date.

Therefore, should the above circumstances exist, then there a potential transaction cost benefit for the following events:

- Sale / purchase of assets though reduction of survey scopes to confidence checking levels only.
- Technical reports relating to scope changes to assets e.g. change of use, extension omissions.
- Routine technical reports. Our analyses of asset performance are reduced to 'data mining' activities supplemented by sample confidence checks.
- Asset value enhancements.

Assuming the above constraints upon the data have been met significantly, higher confidence levels lead to:

- Reduced transaction time.
- Reduced input from specialist technical and legal advisors.
- Reduced fee burden upon transactions.

2.2 BENEFITS OF THE 'BIMASSET'

The benefits of a reliable 'BIMAsset' include the following:

i. Reduces survey costs
ii. Better decision making
iii. Better confidence level in assets
iv. Accurate forecasting
v. Low maintenance cost
vi. Ease of tendering
vii. Enhancing compliance with statuary obligations

- **Reduces Cost:** The 'BIMAsset' if properly managed, will reduce the money spent on the scale of repeated surveys for developments and alterations over the lifecycle of a facility. According to clients' typical surveys on a healthcare facility, cost in the range of an average of £0.80 to £1.50 per m^2 is spent by clients on surveys for facilities. With proper management of the 'BIMAsset', these incurred costs can be minimised by reducing surveys to sample area checking to demonstrate confidence

- **Better Decisions:** In a way, BIM provides an avenue for asset managers to engage in the decision process that will affect the design construction and use of the facility at a much earlier stage (Azhar *et al.*, 2008). This enhances the team's ability to make more informed decisions regarding the facility. The information contained in the document should provide the basis for better projections in terms of planning, maintenance, service life of the facility and reinvestment decisions.

- **Better Confidence in Assets:** The possession of a reliable 'BIMAsset' will provide more confidence in the overall investment because the client can assess the economic performance of the facility at any particular time in its lifecycle.

- **Accurate Forecasting:** Due to the amount of information accessible to managers, forecasting methods can be done more accurately, thus, eliminating further survey costs.

- **Low Maintenance Cost:** If the FM provider updates the BIM model automatically based upon their activities. There is will be no premium charged for maintenance. This symbiotic relationship will create a win-win situation. The client will have an updated 'BIMAsset' while the FM provider will see it as an opportunity to rake in savings through better asset identification and information retrieval. If BIM is implemented and used properly, an average ROI of 5-1 can be achieved on a single project (Munir, 2012). Therefore, ROI of the 'BIMAsset' will cover the cost for the manager required for the maintenance.

- **Ease of Tendering:** If the 'BIMAsset' is maintained properly, tenderers will be able to view the model when bidding for the work and will have enhanced confidence enabling the tender to be priced without 'risk pricing'.

- **Enhancing Compliance**: By ensuring the CAFM system is integral with the 'BIMAsset', the risk of statutory obligations being missed can be avoided.

2.3 VALUE OF THE 'BIMASSET'

Essentially, managers need to ensure that all elements of the facility are properly documented in the 'BIMAsset'. That is, by having inventory of all the basic elements of the facility, building usage, their location and maintenance records. The digital document has to be updated frequently to accommodate further alterations and demolitions.

The evaluation of the 'BIMAsset' value can never be clear-cut because it depends on the overall configuration of the system. This will depend largely on the level of information captured by the organisation. The value in the data will be as a result of accurate forecasting and cost certainty of estimates generated by the system. This can be evaluated with other benefits derived in terms of reduction in cost, rework etc. Value of the 'BIMAsset' will depend on certain circumstances e.g. the level of up-to-date facility information captured. This can be determined using certain valuation techniques like 'performance in use', which is a method used to determine the value of an asset based on benefits for the user (Lemer, 1998). The 'BIMAsset' can be evaluated in relative terms to its condition and derived benefits for the organisation.

Interested buyers can have more confidence in a particular investment by assessing the economic performance of the asset before purchase. This is important because assets are considered to have value if they can generate revenue (Kyle, 2001). The evidence of any potential revenue generation shows the ability of the facility to meet up with current operational and functional requirements of its client. With that, BIM as a complete package could add value to an investment at the disposal (selling) stage of the lifecycle (Munir, 2012). Therefore, a well documented and properly maintained 'BIMAsset' could improve the economic performance of a property / investment.

2.4 SIMILARITY WITH OTHER INDUSTRIES (IN THEORY AND PRACTICE)

Similarities can be found with the IT and manufacturing industries. Theoretically, Lean Production goes in line with BIM methodology. BIM is generally seen as a promising approach that would aid in achieving the principles of lean construction by reducing waste, improving efficiency, enhancing information management and improving communication (Gerber *et al.*, 2010). The work of Khanzode *et al.* (2006) sought to provide a framework that linked BIM to the Lean project delivery by using Virtual Design and Construction technologies. Also, Sacks *et al.* (2009) hypothesized a framework that showed 48 validated similarities between BIM and Lean principles. These supported the notion of high synergy between BIM and Lean. Therefore, BIM is expected to provide the foundation for some of the results that lean construction is expected to deliver (Sacks *et al.*, 2009).

In practice, similarities could be drawn from the manufacturing industry. A similarity to the BIM collaboration process can be found in the Toyota Production System. A vehicle development system called the '*Obeya*' system was developed for the Prius, which is now the new standard for Toyota. The system serves two main purposes, which is information management and on the spot decision making. It enabled project participants to keep track of the project development schedule through the CAD terminals, schedules with checkpoints and other visual management devices. At the end of the programme, a confidential document was forged recording experiences of vehicle development from start to finish in real time (Liker, 2003). The document is relatively similar to the 'BIMAsset', which documents the entire workings of a system throughout its lifecycle.

Another similarity from the manufacturing industry is from the Rolls Royce Company, where they have a similar system to the proposed 'BIMAsset' which is called Optimized Systems and Solutions (OSyS). This Business management solution has enabled Rolls Royce to generate and update business plans, achieve growth in the services business with 20 percent fewer staff, realise 80 percent reduction in queries regarding forecasts, have an integrated financial model, and have better visibility of quality data through a central database. It also gives the company the opportunity to make informed business decisions and to achieve other operational savings by generating frequent KPI reports that enhance the maintenance schedule which reduces number of maintenance visits and eliminates the need for open subassemblies through database verification (OSyS, 2012). In a way, if the 'BIMAsset' can have similar impacts in the

construction industry, building operators will benefit greatly from the use this system because it will improve the quality and integrity of forecast data.

2.5   COMPROMISES

Certainly, there can never be any perfect system or methodology and compromises have to be made. The system will largely depend on human input for the overall workings of the system. The 'BIMAsset' will greatly depend on the skill of the asset valuation team/advisors, their level of knowledge to understand the data. Finally, the system will depend on the ability of clients, technical advisors and those people who divest to do due diligence or understand what they are buying. The use of BIM is a technologically sophisticated process; therefore, with incompetent users, unstable applications or inadequate management, the entire process can become complicated (Sacks *et al.*, 2009).

3.0   COMPOSITION OF THE 'BIMASSET'

The 'BIMAsset' like all other products requires resources as inputs in order to generate a reliable 'BIMAsset'. In this section we will outline the requirements, process, value, and confidence levels of the 'BIMAsset'.

3.1   REQUIREMENTS

The basic requirements for the development of a 'BIMAsset' include the following:

i.   BIM Technologies
ii.   Current Facility Configurations
iii.   Models
iv.   Contractual Structure
v.   Asset Coding and Data Maintenance
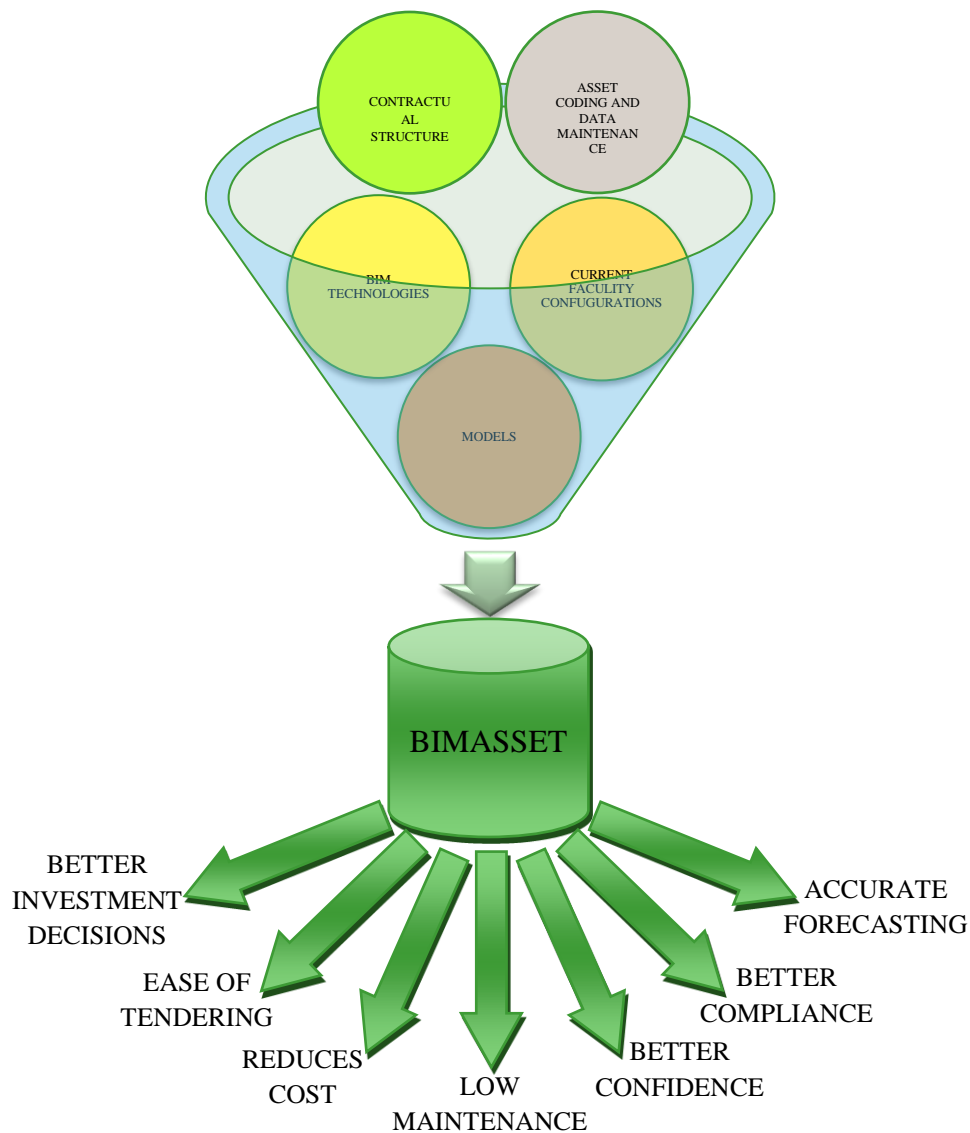
Figure 3: Shows the Composition of the 'BIMAsset'

3.2   CONFIDENCE LEVEL

The confidence level of a 'BIMAsset' depends on the level at which the BIM database is updated. The figure below represents the confidence in 'BIMAsset' depending on how current the BIM dataset is throughout the lifecycle of a facility. This shows that with low confidence in the 'BIMAsset' for a frozen BIM dataset diminishes to a point where the users have no confidence in the data and the BIM investment is lost.
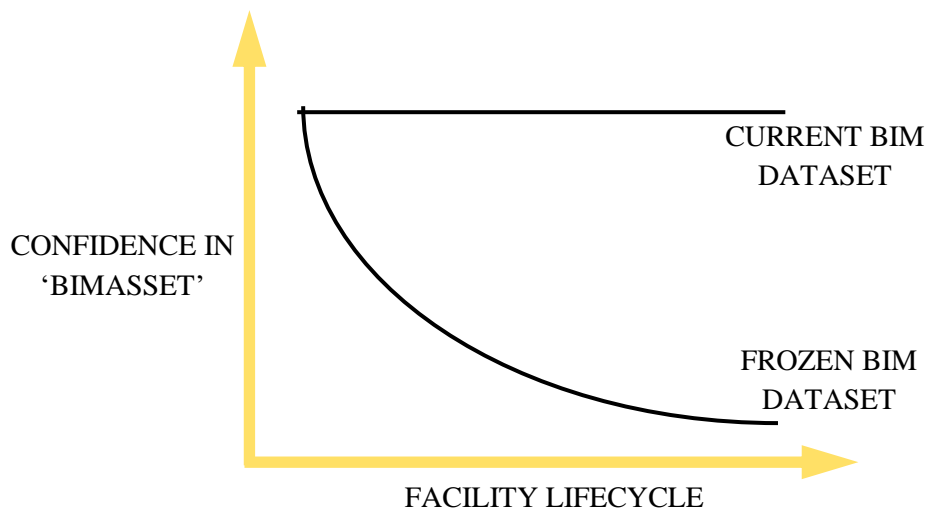

Figure 4: Shows Client Confidence in 'BIMAsset'

The following figure identifies a simple indication of the proportion of the assets replaced for a typical healthcare facility totalling 26 % after a 30 yr period, equating confidence to the proportion of assets replaced over a given period is not appropriate as differing sub components of the 'BIMAsset' data will have differing weightings.
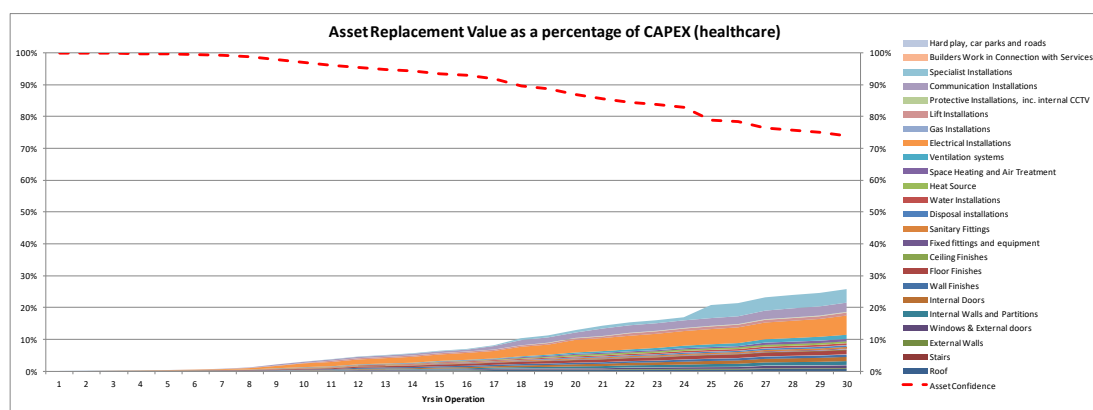

Figure 5: Shows Asset Replacement of a Facility

3.3 PROCEDURE/PROCESSES

This paper proposes some measures for establishing a reliable 'BIMAsset', they are:

- **Contractual Agreements:** Responsibility has to be assigned and stated clearly in the construction contract for managing the BIM data at handover. The contract should stipulate that the FM provider updates the BIM model automatically as part of their contractual responsibilities.

- **Transfer after Construction:** Handover of the BIMAsset at the end of the construction (Soft Landings). Although the handover will have a defined date in the Contractual agreements the handover will be a gradual process where the CAFM implementation develops during the design and is implemented before the completion of construction.

- **Maintenance/Updating:** BIM maintenance should be treated as part of the BIM manager and FM's responsibility. If this method is adopted, both parties with will benefit from the process.

- **COBie/CAFM:** Implementation of the COBie format and selection of the CAFM vendor / operator influenced by their abilities to use / interface with the BIM data this should be a bidirectional link.

3.4 STRENGTHS/WEAKNESSES

The strengths and weakness of the system have to be identified. Some of them are:

- **Complexity:** Implementation of 'BIMAsset' requires significant effort and encompasses many threads including formats, contractual relationships and maintenance.

- **Scale and Asset Type:** Interviews have indicated that the value of 'BIMAsset' is unlikely to be attractive on small scale projects of limited complexity or on commercial developments during the early adopter phase; however, on highly serviced high value or high risk assets there is potential.

3.5 TYPES OF BIM DATA NECESSARY TO ENHANCE BUILDING OPERATIONS

The following are some of the data which can be derived from the entire BIM process in order to enhance building operations of a facility. Some of them are:

- **Design Data:** Models and supporting calculations for structural and services systems.

- **Product Information:** Material data, attributes, maintenance obligations and regimes.

- **Asset Coding:** Reference and coding structure enabling the interface between the data from the construction phase and the derived data during the operational lifecycle phase.

4.0   CONCLUSION

There are a variety of methods and techniques for making rational asset management decisions in order to ensure effect management of facilities. The 'BIMAsset' is seen by the authors as a dataset that could provide some information which clients / managers have never been able to access. This paper highlights the existence of the 'BIMAsset' dataset, challenges, compromises, benefits, and how to overcome some of the issues.

The research proposed hypothesis for this study. The interviews and literature review have provided a basis for validating the hypotheses.

- H_1 (Existence and composition of the 'BIMAsset'): This can be validated from a range of issues reviewed in this study. It is not know whether all the issues regarding composition have been identified in the research. This is because the definition of the 'BIMAsset' by the client/manager will determine its full composition.

- H_2 (Confidence level of the 'BIMAsset'): This could not be validated from the interviews conducted. This is because confidence levels are dependent on many factors which are project specific and are subjective in nature.

As a concluding note, it is the view of the authors that by considering the lifecycle of the BIM data 'BIMAsset' there is significant potential to derive enhanced asset value; including financial, time saving and risk / compliance.

4.1   LIMITATIONS

Maintenance of the BIM data and development of the 'BIMAsset' is dependent upon considering and establishing the technical and commercial framework at the projects design stages to ensure that it has become fully established before the Asset enters the operational phase of its lifecycle.

4.2   FURTHER RESEARCH

Additional research could be conducted under this topic by taking a survey to determine the confidence level of built assets from building operators. Also, further research needs to be conducted on the analysis of the confidence level of built assets considering that the individual elements of built assets will have different weightings.

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