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A critical appraisal of BIM implementation in the context of environment performance enhancement in the construction industry

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Introduction

A mismatch has been observed between predicted energy performance and actual measured consumption, often termed the 'performance gap'. This is a major concern given the significant contribution of the building sector to global energy use and greenhouse gas (GHG) emissions[1,2]. Current efforts to digitise the construction industry should therefore be aligned with achieving energy efficiency during operation to closer match the expectations during the design stage.

There is potential to facilitate this through the current ubiquitous effort to phase the adoption of a fully integrated Building Information Modelling (BIM) approach into the construction industry.

Benefits of adopting BIM:

- Time & cost savings
- Enhanced collaboration
- 3D coordination

Drivers for adopting BIM:

- Governmental & competitive pressures
- Public sector support
- Clash detection activities

Green BIM

The are two forms of environmental benefits:

Implicit – Benefits which occur as a natural consequence to using BIM

Explicit – Benefits gained from specifically using tools & processes to achieve sustainable outcomes and design optimisation, or 'green BIM'.

'Green BIM' has been defined by Wong and Zhou as:

"a model-based process of generating and managing coordinated and consistent building data during its project lifecycle that enhance building energy efficiency performance, and facilitate the accomplishment of established sustainability goals"[3]

There is a deep-seated requirement to further develop the use of green BIM as most efforts to date have been primarily focused on the development of tools rather than improving the underlying process.

Decision-Making Aids

There are 2 core issues with the current decision-making process:

- The current procedure for calculating energy performance is insufficient
- Building professionals may lack the knowledge required to design truly energy efficient buildings

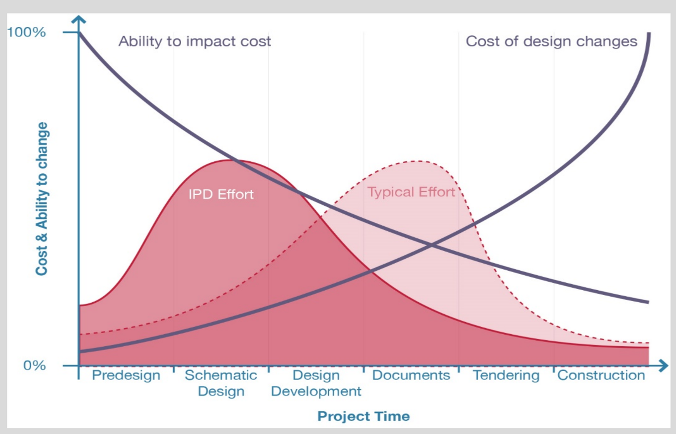

Figure 1 – MacLeamy Curve, reproduced from Davis[4]

BIM enables more data to be available earlier in the process to aid decision-making through Integrated Project Delivery (IPD). This enables more effective decisions to made in aspects such as lifecycle assessments (LCAs), environmental assessment methods (EAMs), and design optimisation when compared to the traditional design process.

The Underlying Process

There is an overwhelming tendency to lean towards routine methods which are demanded from compliance procedures. Existing frameworks have been adapted to suit BIM and are thus unsuitable for achieving optimal energy efficiency beyond regulatory requirements. Industry culture is not satisfactorily focused on the issue of energy performance. The drive to implement BIM should therefore act in itself as a steering mechanism to encourage green design rather than hinder current efforts.

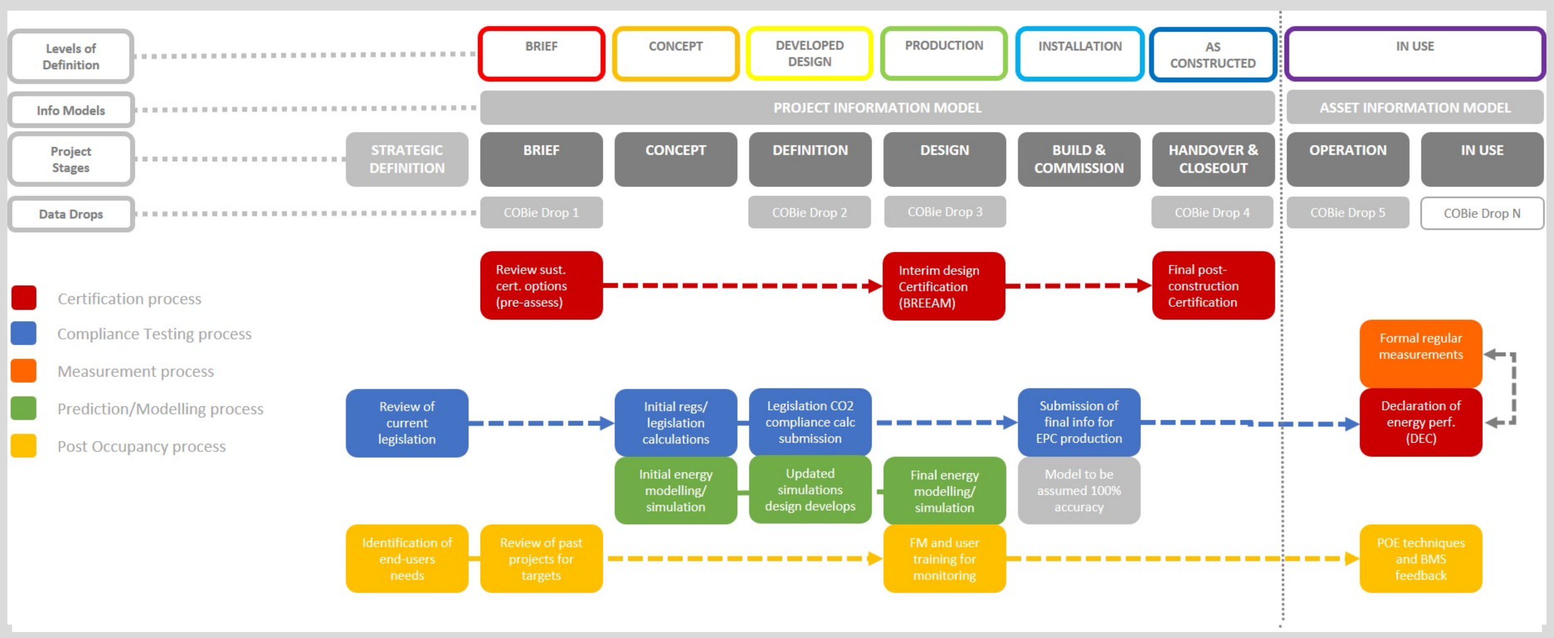

Figure 2 – Current sustainable design and energy prediction process within the BIM framework

BIM Adoption

The overall uptake of BIM can be described as plateauing and has not penetrated the supply chain as much as hoped. For BIM adoption to be truly effective, the entire supply chain needs to implement it wholly within their practices at a homogenous level of maturation. However, adoption can be shown to be following the accepted paradigm of the Rogers curve, which means adoption is slowing and contradictory to the projected ambitions of the industry.

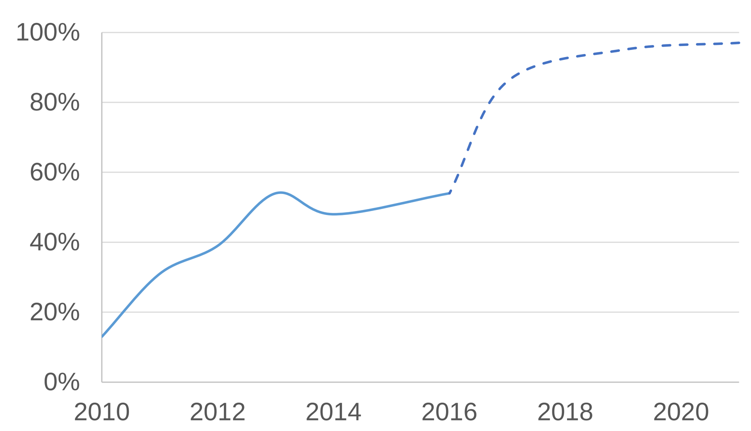

Figure 3 – Actual and projected BIM adoption rates. Data from NBS[5,6,7]

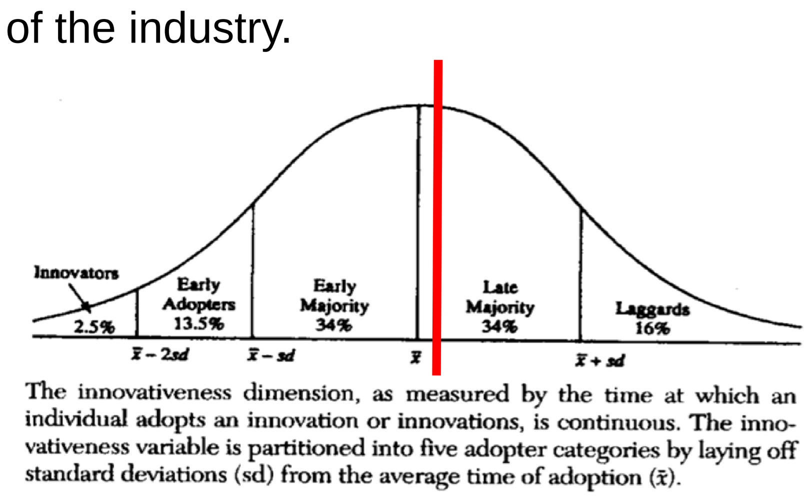

Figure 4 – Adopter categorisation on the basis of innovativeness, adapted from Rogers[8]

Currently, there is no benchmarking mechanism for BIM implementation in Scotland and the rest of the UK which makes understanding the exact levels of maturation difficult. The NBS National Surveys have a broad scope but should be used as an indicative metric rather than an accurate representation.

BIM adoption surveys can mask a serious lack of understanding of BIM usage. This is exemplified by the fact that 35% of those surveyed are using Levels 0 or 1 which are not truly BIM, and Level 3 which is not yet defined,

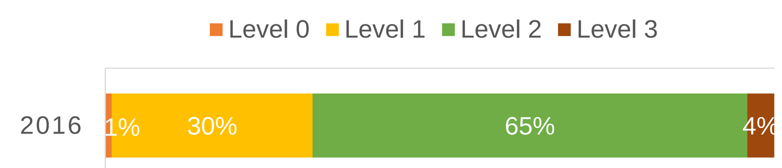

Figure 5 – Highest Level Achieved on a Project. Data from NBS[7]

Implications of a slow uptake include negative impacts on:

- Practices' individual market presence
- Movements towards a single-model environment (Level 3 BIM)
- Improving current, stagnated sustainable design processes

Barriers to effective implementation:

- Industry culture/reluctance
- Cost implications
- Lack of standardisation

Key Findings

- The drive for BIM adoption is well-founded based on its perceived benefits
- BIM provides 'implicit' & 'explicit' environmental benefits
- Green BIM is synonymous with the 'explicit' benefits
- The current structure for energy efficient design is limiting, therefore needs to be reviewed with a focus on energy performance prediction
- For this to be realised, BIM needs to be fully adopted within the entire industry
- BIM is following a typical trend in adoption rates, but should break this paradigm to effectively work

Future Work

This study has primarily focused on the inefficiencies associated with the design stage. These are often attributed to the existence of the energy performance gap. Future efforts should review and analyse the role of operational BIM within the context of actual energy consumption.

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