The key performance indicators of the BIM implementation process

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Abstract

At the present time some firms in the construction industry are attempting to adopt a BIM methodology of working. Each of these attempts reflects a varying BIM adoption philosophy and inevitably different BIM technologies, implementation strategies and roadmaps. These attempts are motivated to attain competitive advantages for product delivery in the market place. The question of what is the best method of adopting BIM has not yet been answered. That is to say, a standard method remains to be identified, that will benchmark the different BIM adoption strategies by comparing the efficiency gains in each case. Through developing a standard benchmarking method stakeholders will be able to decide on the most appropriate strategies for themselves.

This paper explains the live experience of BIM adoption in a KTP (Knowledge Transfer Partnership) project, undertaken between the University of Salford and John McCall Architects practicing in the housing and regeneration fields, with a particular focus on a set of KPIs that have been developed and tested through the action research strategy in the project. Weighting of these KPI's has been developed from an architectural business perspective.

Keywords: Building Information Modelling, Key Performance Indicators, benchmarking, Action Research, BIM Adoption and Implementation

1 Introduction

BIM represents the new cornerstone that is being adopted to facilitate ICT in the business of architecture. Architectural design is an aggregation of many information exchanges between people within and between organizations (Jin and Levitt's Virtual Design Team 1996). In the construction industry, the design process disproportionately influences the life cycle value of the resulting products

(Paulson 1976). It is widely known that poor design has a very strong impact on the level of efficiency of the project during the construction stage as well as the quality of the final product.

Many papers have been written concerning design and construction excellence. These tend to focus on the KPIs that show how organizations are operating to benefit the construction industry or to provide a better end product. But regard to company KPIs, there are two sets of performance indicators; i) how well the adoption of the BIM concept, ii) how beneficial the adoption of BIM to the business. Both are important and do not operate in isolation but are complementary parts of the overall picture of the successful business. In order to justify a business case for BIM adoption, the business related KPIs need to be established.

The paper aims to identify a method by establishing a set of KPIs to measure the success of different BIM adoptions. When the comparable results are evaluated, the roadmap of BIM adoption can be re-devised for the architectural firms for successful and smoother transition.

2 The Case Study Company: John McCall's Architects (JMA)

The company was established in 1991 in Liverpool in the UK, and has been involved in architecture and construction for more than 17 years designing buildings throughout Northwest England. Focusing primarily on social housing and regeneration, private housing and one off homes and large extensions, the company is known for good quality, economical, environmentally sustainable design. JMA works with many stakeholders from the design through to building construction process and the associated information is very fragmented.

3 Knowledge Transfer Partnership Project with JMA

The KTP project aims not only to implement BIM and therefore assess the degree of the successful implementation, but rather to position this within the context of value-add offerings that can help the company place itself at the high-end knowledge-based terrain of the sector. The KTP adopts a socio-technical view of BIM implementation in that it does not only consider the implementation of technology but also considers the socio-cultural environment that provides the context for its implementation. Within this context change management and adoption strategies will be a challenge.

The KTP will enable JMA to establish itself as the vanguard of BIM application giving them a competitive edge because BIM can enable the intelligent interrogation of designs; provide a quicker and cheaper design production; better co-ordination of documentation; more effective change control; less repetition of processes; a better quality constructed product; and improved communication both for JMA and across the supply chain.

The impact of the KTP will be also to improve the process at every level and stage: eliminating the risk of calculation, misinterpretation of design, improve communication, provide interoperability between stakeholders and, ensuring control and sharing of documentation. This is because BIM is a foundational tool for implementing an efficient process and invariably leads to lean-orientated, team based approach to design and construction therefore BIM will allow JMA to demonstrate the entire building life cycle including the construction and facility operation during the design phase.

4 BIM Implementation Approach

The project aims to enable the growth of John McCall Architects by integrating and reengineering its processes and through establishing a niche capability in BIM, both with its clients and through the supply chain. BIM implementation and adoption is planned through the stages summarized in table 1 below.

Table 1: BIM Implementation Approach for JMA's Design Practice

Stage 1: Detail Review and Analysis of Current Practice	Production of Current Process Flowcharts Soft System Analysis Review of IT systems Stakeholder Review and Analysis Identification of competitive advantages from BIM implementation
Stage 2: Identification of Efficiency gains from BIM implementation	Efficiency gains from BIM adoption
Stage 3: Design of new business processes and technology adoption path	Production of detail strategies Documentation of Lean Process and Procedures Identification of Key Performance Indicators
	Documentation of BIM implementation plan
Stage 4: Implementation & roll-out of BIM	Piloting BIM on three different projects (past, current, and future) Training the JMA staff and stakeholders Devising and improving companywide capabilities Documentation and integration of process and procedures
Stage 5: Project review, dissemination and integration into strategy plan	Sustaining new products and processing offerings Evaluation and dissemination of the project

4.1 Identification of Efficiency Gains from BIM Implementation

BIM implementation strategy and subsequent expected efficiency gains from BIM adoption may have variation depending on the needs, requirements and the envisioned scope for improvements in the business. The main characteristics of BIM implementation strategy and the subsequent efficiency gains are clarified after the detail review and analysis of current practice. This includes i) process mapping of current practice at JMA, ii) conducting soft system analysis, iii) stakeholder review and analysis and finally iv) identification of competitive advantages from BIM implementation. Completion of these diagnostic activities has led to make some decisions to identify the scope and the characteristics of the actual BIM Implementation and adoption strategy. These are listed below

- Decision on the usage of the BIM tools
- Decision on the approach for BIM adoption, top-down (client driven) or bottom up (driven by the members of the building team).
- Decision of the scale of the BIM adoption; the whole building process or maybe at specific stages addressing specific problems.
- Decision on the BIM adoption at single disciplinary or multi-disciplinary: The major benefits can only be made through a multidisciplinary BIM adoption approach.
- Decision on Single model accessibility on single server or federated model accessibility on a multi-server system: The working procedures need to reflect the approach adopted.
- Decision on the balance between BIM training and education; while training teaches staff how to do, education gives people how to think.
- Decision on recruiting or training BIM Champion / BIM team
- Decision on the rate of adoption – appropriate program (The appropriate rate of BIM adoption depends whether it is internal driven or market driven. Later adopters may need to adopt BIM faster to collaborate with other consultants who have already gone through it.)

- Decision on the areas of the production to be integrated
- Decision on the changes in the business model
- Decision on Job-led or process-led BIM adoption
- Decision on BIM adoption as a single solution or part of a suite of solutions
- Decision on method of model analysis when BIM is adopted; for example thermal and environmental analysis
- Decision on methods of data transfer and interoperability
- Decision on task and role allocation to staff

In fact, these decisions show the reflection of the transition from the stage 1 to stage 2. The existing skills, the IT infrastructure available and the other stakeholders in the construction process were also taken into consideration when those decisions above were taken. Decisions made in one area will affect those made in another. Making these decisions is best facilitated with the use of a scorecard. At JMA a weight was given to each decision. These decisions have helped determine the roadmap and the resources required for the BIM adoption and subsequently the identification of the efficiency gains from the BIM adoption, which are listed below.

Short Term Gains

- The quality, speed and cost of the services JMA provides
- Automatic low-level corrections when changes are made to the design through the use of parametric relationship between objects
- Generate accurate and consistent 2d drawings throughout the design
- Visualizations to allow checking against design intent
- Discovering design errors before construction

Medium Term Gains

- Information sharing
- Greater flexibility to satisfy customers
- Better financial control
- Simultaneous work by multiple disciplines

4.2. The Identification of Key Performance Indicators (KPIs)

In order to derive the KPIs, it is necessary to understand the organizational inputs, outputs, and desired outcomes and these KPIs should be as closely linked as possible to the top-level goals of the business. Specifically with BIM, there has been a lack of consistent fiscal benchmarking to evaluate the business improvements and gains from BIM adoption (Gerber & Rice, 2009). Using the diagnostic material from stage 1 and 2 of the BIM implementation approach, the following attributes are sought for the definition of KPIs:

- Does the KPI motivate the right behavior?
- Is the KPI measurable?
- Is the measurement of this KPI affordable (cost-effective)?
- Is the target value attainable?
- Are the factors affecting this KPI controlled by you?
- Is the KPI meaningful?

The following steps have been undertaken in the KPI identification.

- Step 1: conducting brainstorming sessions in JMA and interviewing the external stakeholders JMA collaborates:
- Step 2: Filling out the KPI design form for all the potential KPIs collated from the brainstorming sessions and the interview with the external partners
- Step 3: Evaluation and assessment of the potential KPIs from step 2 to filter them against the checklist above recommended by Gerber & Rice, (2009)

This process has led to finalized identification of the KPIs for the evaluation of the business improvement in JMA and subsequently the assessment and measure the extent of the success of BIM adoption.

4.3. List of KPIs Identified for JMA business

- Man hours spent per project - efficiency with cost per project: It is possible to compare the man-hours spent on one project that utilises BIM software with the man-hours spent on the same project using a traditional CAD system.
- Speed of Development: Turnaround time is important and if handled correctly, it can reduce outstanding work and costs, and improve cash flow. In addition, speed of turnaround also engenders client satisfaction.
- Revenue per head: Higher revenue per head is achieved when fees increase. Clients will only pay more if they perceive greater value. The potential value of BIM for many clients remains unproven in areas such as facilities management.
- IT investment per unit of revenue: The use of IT has become a prerequisite of architectural practice and many IT solutions exist. It is important to measure the success of one IT innovation against other potential innovations.
- Cash Flow: On a daily basis, cash flow is not profitable every day, but setting and achieving a daily margin of profitability is critical to success. Successfully monitoring cash flow allows meeting obligations and protecting the future. By increasing the rate at which product is turned around enables invoices to be raised earlier and liquidity can be maintained.
- Better Architecture: Whether architecture is better or not is dependent on the individuals' perspective. How to achieve better architecture is critical by making better informed decisions. The use of BIM claims for greater investigation and understanding which has the potential to lead to better decisions and better architecture.
- A better product: Many facets attributes to BIM have the potential to produce a better product through the reduction of mistakes, clash detection, automated model checking, reduction in build ability issues, reduction in professional insurance costs, etc
- Reduced costs, travel, printing, document shipping: Travel expenditure in time and money may be reduced to fewer issues. Printing costs may be saved because less check sets of drawings will be necessary. Document shipping should be reduced when a single multidisciplinary federated model is used.
- Bids won or win percentage; BIM is supposedly a marketable commodity and helps attaining competitive advantage to win bids, which is based on many different factors. Most of the work gained by JMA is through framework bids through long term partnerships.
- Client satisfaction and retention: capturing client requirements and needs and establishing a shared understanding with them on the design and developing a partnering approach are critical and involving them throughout the process to inform and receive feedback from them can be achieved through BIM adoption in order for client satisfaction and retention.

- Employee skills and knowledge development: staff reaction and acceptance, their cultural attitudes, their skill and knowledge level and related BIM training should be also measured and managed accordingly.

Weighting and Normalizing should be carried out once data is gathered on the individual KPI's. Where two KPIs measure similar aspects of performance in different perspectives or contribute to more than one aggregated metric, the KPIs should be weighted accordingly.

5. Conclusions

In simplistic terms the architectural business can be described as delivering on a promise. BIM is a consumable commodity, not a capital investment. It is of value only to the extent that it enables organizations to fulfill their mission. The technology, process and organizational investments required to implement BIM are considerable and costly. Thus, the return on investment needs to be justified. Therefore, KPIs should be measures of risk to annual goals or strategic objectives.

It has been realized that KPIs enable to structure and present information in a systemic way in order for accurate measurement and observation of business improvements from BIM adoption. As a result, KPIs can form a method of comparing the success of different BIM adoptions in terms of:

- Measuring the quality of projects
- Standardizing information and measurement process throughout the community
- Setting appropriate benchmarking targets
- Recording effectiveness of action

6. References

GERBER,B.,RICE,S.,(2009), The Value of Building Information Modeling: Can We Measure the ROI of BIM? *AECbytes* Viewpoint #47 (August 31, 2009) Available online http://www.aecbytes.com/viewpoint/2009/issue_47.html

TATSIANA, H., SAAD, A.J., (2007), Identifying the KPIs for the design stage based on the main design sub-processes, *SAP Strategy Management*, September 2007

CHAN,A.P., and CHAN,A.P., (2004), Key performance indicators for measuring construction success, Benchmarking, 11(2), 203-221.

NOUR,M.,FIRMENICH, B.RICHTER,T.,KOCH,C.,(2006), A versioned IFC database for multidisciplinary synchronous cooperation, *Joint International Conference on Computing and Decision Making in Civil and Building Engineering, June 14-16, 2006 - Montréal, Canada*

PAULSON, B.C.J. (1976), Designing to reduce construction costs, *Journal of the Construction Division* 102(4) 587-592

SCHEURER F., (2007), Getting Complexity Organized Using self-organization in architectural construction, *In Automation in Construction* 16, 2007

SENESCU R., HAYMAKER J.R., (2009), Specifications for a Social and Technical Environment for Improving Design Process Communication, Center for Integrated Facility Engineering, Stanford University, Stanford, CA USA

SUERMANN, P., Maj C, (2007), Evaluating the impact of building information modelling (BIM) on construction, *ITcon* Vol. 14, pg. 574-594, Available online http://www.itcon.org/2009/37

SUN, Z., CAO, Y., (2006), Small and Medium-sized Enterprises Target System's Design of Key Performance Assess , *International Journal of Business and Management*, Vol. 1, No. 5

SAWANG, S., (2007), The Discrepancy between the Managerial Perceived Importance and the Actual Use of Key Performance Indicators for Measuring Innovation Effectiveness, Proceedings of the 13th Asia Pacific Management Conference, Melbourne, Australia, 2007, 157-162

THOMSEN, J., RAYMOND E., CLIFFORD, L., NASS, I., (2005), The Virtual Team Alliance (VTA): Extending Galbraith's Information-Processing Model to Account for Goal In congruency, *Computational & Mathematical Organization Theory* Volume 10, Issue 4, pp: 349