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Adapt or Die! Building Information Modelling (BIM)

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ABSTRACT AND KEYWORDS

Purpose: The emergence of Building Information Modelling (BIM) demands that quantity surveyors review their roles in the construction sector. This study examines the responsiveness of the quantity surveying discipline to BIM.

Design/methodology/approach: A sample of quantity surveyors in Durban will be surveyed using an instrument developed from published literature on responses of quantity surveying to BIM.

Research limitations: The sample of quantity surveyors was drawn from the Durban area using the Association of South African Quantity Surveyors (ASAQS) and South African Council for the Quantity Surveying Professions (SACQSP) database.

Findings: Preliminary findings suggest that quantity surveyors' knowledge about BIM, software and innovation was at best rather average. They recognized the most obvious benefits of embracing BIM such as the time taken to produce Bills of Quantities and accurate cost estimation. Largely because of their lack of knowledge of available technologies they could not comment assertively on many of the issues surrounding the relationship between BIM and quantity surveying. This further resonates with the uncertainty that exists surrounding BIM and its business value and return on investment. They disagreed that technological advancements presented threats to their existence or the services that they traditionally offered. In the main the findings of the study resonated with those of other studies done particular in developing countries.

Response to conference theme: This study identifies the reasons why BIM is not being readily embraced by quantity surveyors more pervasively.

Practical implications: The findings provide the opportunity to improve the services currently offered by quantity surveyors but also new and innovative services driven by BIM

Keywords: Quantity surveying, BIM, computer hardware, computer software

Conference sub-theme: *Construction Education*

1. INTRODUCTION

BIM technologies, processes and policies are significantly impacting industry's deliverables, relationships and roles (Succar and Kassem, 2016). BIM, as a process, allows the exchange of information among the project stakeholders, such as architects, engineers, contractors, consultants and clients (Teo, *et al*, 2016), and by inference quantity surveyors. While the technology underpinning BIM has been around its implementation and take-up has been particularly slow in the construction sector. BIM provides opportunities and challenges for the quantity surveying discipline. As a consequence the role of the quantity surveyor of necessity must also adapt to provide more sophisticated services as part of the evolving integrated project delivery approach. This study examines the perceived impact of BIM on the quantity surveying discipline as currently practised in KwaZulu-Natal to determine the level of knowledge of BIM and the readiness of the discipline to embrace BIM.

2. DEFINING BIM

According to Building Smart (2012:7) BIM is defined as:

… a 3D object database that can be easily visualized, has rich data and structured information. Building Information Modeling is a process of representing building and infrastructure over its whole life cycle from planning, design, construction, operations, maintenance and recycling. BIM importantly provides a framework for collaboration, a multi-disciplinary environment that brings together all the parties that design, construct and operate a facility, suggesting a new model of procurement, Integrated Project Delivery (IPD).

According to RICS (2012) BIM requires a different way of thinking and a new approach to project procurement and delivery with BIM becoming the primary tool for the entire project team.

3. THREATS TO THE ROLES OF QUANTITY SURVEYORS

Every profession must evolve in response to the ever-increasing changes in the global economy and quantity surveying practices are not absolved from this challenge (Frei, Mbachu and Phipps, 2013; Oyewobi, Ibironke and Oladosu, 2015). The traditional role of quantity surveyors may be viewed as providing the financial and commercial management services on construction projects – also known as a building economist (Cunningham, 2014). These traditional roles include:

- Preparing approximate estimates of costs;
- Cost planning and value analysis;
- Advising on procurement options;
- Preparation of bills of quantities and other contract documents;
- Adjudication of tenders;
- Negotiation of rates;
- Valuing work in progress;
- Preparing final accounts;
- Advising on contractor claims;
- Advising on costs and preparing cost reports;
- Giving specialist advice such as, for example, technical auditing, valuations for insurance, advising on taxation and capital allowances, risk analysis and management, project management, health and safety and quality (Hore, O'Kelly and Scully, 2009).

According to Frei and Mbachu (2009) the quantity surveying discipline needs urgent and far-reaching transformation if it is to survive and remain relevant. Ofori and Foor (2009) opined that many observers have predicted and many within the discipline itself fear that quantity surveying might disappear as a formal profession. Frei, Mbachu and Phipps (2013) identified a list of threats to quantity surveying, namely market/competition, capability/capacity. Recognition/relevance and information/communication/technology. Threats included the following:

- Continued departure from traditional procurement methods and associated fall in demand for quantity surveying services;
- Relative obscurity of the quantity surveying discipline;
- Blurring of professional boundaries allowing erosion of existing market share by other professionals;
- Shortages of suitably skilled professional and quality graduates threatening long term success of discipline;
- Advances in information technology such as computer-aided drafting (CAD) and BIM threatening the role of quantity surveyors;
- Building market fluctuations; and
- Demise of published scales of fees and resultant levels of fee competition affecting quality of services offered.

4. ADOPTION OF BIM

A study by RICS (2011) found that 61% of the quantity surveying firms that they had surveyed had no engagement with BIM. For those using BIM the most frequent use was for construction scheduling (14%) followed by extraction of quantities and facilities/asset management (8% each). Only 4% of quantity surveying practices regularly invested in BIM training and only 10% actively assessed BIM tools for potential adoption. These findings suggest that QSs are not embracing BIM as pervasively as they could. The barriers cited were lack of client demand, training, application interfaces and standards. In their study Ashworth, Hogg and Higgs (2013) found that the five most dominant problems of using computers in quantity surveying were maintaining programs, integration of processes, cost containment, recruitment, and meeting project deadlines.

The move towards BIM capability and expertise requires quantity surveying practices to re-evaluate and re-engineer their business practices (RICS, 2011). BIM enables collaboration between users through better visual understanding of the building artifact (Matipa, Cunningham and Naik, 2010). BIM is able to generate and analyse different views, data and information appropriate to various users' needs, which can be used to facilitate decision making and to improve the process of delivering the facility (AGC, 2010 cited in Teo *et al*, 2016). The important feature of BIM is its capability to enable the item to be constructed to be built virtually, prior to building it physically, in order to identify and resolve problems, and simulate and analyze potential impacts (Smith, 2007 cited in Teo *et al*, 2016). BIM can be used for many other purposes in the design and construction process such as visualization, scope clarification, trade coordination, collision detection and avoidance, design validation, construction sequencing planning, plans and logistics, marketing presentations, options analysis, walk-throughs and fly-throughs, virtual mock-ups and sight-line studies (AGC, 2010 cited in Teo *et al*, 2016).

According to Gerrard et al. (2010) the lack of BIM expertise, lack of awareness and resistance to change were the main barriers to BIM adoption (cited in Zhao, Gao and Pienaar, 2016). Where they have been used they have been at the basic stages only with no advancement into the usage of sophisticated software because of the negative perceptions and fraudulent activities. The construction industry, and by inference quantity surveying, has been found repeatedly to be reluctant to apply new technologies and employs lower levels of BIM than other industries (Yang, 2007). Further, organizations tended to resist giving up and changing established ways of doing things and familiar BIM products (Lawrence and Scanlan, 2007). This tendency is referred to as organizational inertia. The scarcity of BIM conversant practitioners and the lack of highly skilled cross trained staff with both construction and IT skill are some of the major barriers hindering the widespread adoption and realisation of BIM benefits (Hartmann & Fischer, 2008; Fox and Hietanen, 2007; cited in Nuramo and Haupt, 2016)

It is argued that lack of skilled and knowledgeable professionals is one of the bottlenecks for successful implementation of the technology in developing countries (Nuramo and Haupt, 2016). It is further argued that unclear business value and return on investment (ROI) are often identified as barriers for adoption (Barlish & Sullivan, 2012 cited in Sanchez, Mohamed and Hampson, 2016). Firms implementing BIM have also stated that a major challenge towards their adoption of BIM has been that that they themselves have not had sufficient time to evaluate the business value of BIM and experience a lack of knowledge about the business value of BIM ((McGraw-Hill 2009, 2010) FMI and CMAA 2007, cited in Vass, 2016). It is therefore important that quantity surveyors appreciate BIM, understand their potential and develop and employ effective processes and tools to integrate technologies into their current practices (Cartlidge, 2011).

5. RESEARCH APPROACH

A convenience sample of 45 quantity surveyors either employed or practicing for themselves in the Durban area of the KwaZulu-Natal province of South Africa were surveyed about their views of the impact of BIM on quantity surveying. The data was collected via a quantitative questionnaire survey comprising of several sections such as knowledge and experience of BIM, benefits, barriers and readiness. Almost all questions took the form of statements around the various themes which required a scaled response of agreement. Descriptive statistics were derived using SPSS v23 and presented including measures of central tendency and dispersion. The internal validity of scaled responses was determined by the Cronbach's alpha co-efficient for validity.

6. RESEARCH FINDINGS

Profile of respondents

Most respondents had been in business for between 1 to 10 years (63.6%) and between 11 to 20 years (31.8%). Just more than half of the respondents (56.1%) considered their practices or firms ready for BIM and its introduction. They rated their knowledge and experience of BIM and its related applications as shown in Table 1 with 1=very low and 5=very high.

Table 1. Knowledge and experience of BIM, software and innovation (n=42)

	1	2	3	4	5	Mean	SD
Knowledge	2.4	26.2	45.2	23.8	2.4	2.98	0.84
Experience	19.0	38.1	28.6	14.3	-	2.38	0.96

Respondents tended to have less than average knowledge (mean=2.98) and experience (mean=2.38) of BIM and its related applications. Respondents were neutral (mean=3.07) on the introduction and adoption of BIM in quantity surveying and the potential reshaping of quantity surveying roles and practices that it will introduce possibly because of their lack of knowledge and experience of BIM.

Reliability

Table 2 shows the Cronbach's alpha co-efficient for the scaled responses of each of the four constructs. There is an acceptable degree of internal consistency for the scales used for all the constructs, namely a Cronbach Alpha statistic which is greater than the rule-of-thumb 0.70) for acceptable internal scale consistency. There is therefore between 72.4% and 87.4% probability that the constructs each measure a single underlying concept with an error of at most 5%. The scales used to measure the perceptions of BIM and its related applications in quantity surveying are therefore acceptable in their measure of the reliability of the constructs.

Table 2. Reliability statistics

Construct	Cronbach's alpha co-efficient (n=42)
BIM and quantity surveying	0.724 (25 items)
Benefits of BIM	0.824 (8 items)
Barriers of BIM	0.874 (8 items)
Knowledge and experience	0.823 (2 items)

BIM and quantity surveying

Respondents were presented with 25 statements about BIM and its related applications and quantity surveying and were asked to indicate their level of agreement on a 5-point Likert scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. The findings are shown in Table 3 ranked by the means of their responses.

Table 3. BIM and its related applications and quantity surveying (n=42)

Factor/Influence	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	SD	Rank
Software reduces the time to produce BoQs	2.4	4.8	2.4	50.0	40.5	4.21	0.90	1
BIM increases efficiency of quantity surveying	-	-	19.0	59.5	21.4	4.02	0.64	2
Cost estimation can be improved by BIM	2.4	9.5	-	64.3	23.8	3.98	0.92	3
BIM promotes collaboration between stakeholders	-	2.4	19.0	59.5	19.0	3.95	0.70	4
BIM requires new skills and knowledge	-	11.9	16.7	40.5	31.0	3.90	0.98	5
BIM allows the quantity surveyor to focus on strategic activities	-	4.8	28.6	52.4	14.3	3.76	0.76	6
BIM enhances life cycle costing data provision to clients	2.4	4.9	26.8	51.2	14.6	3.71	0.87	7
BIM automates taking off and BoQ production	4.9	7.3	24.4	52.1	12.2	3.59	0.97	8
BIM increases program certainty at the tender stage	-	9.5	38.1	38.1	14.3	3.57	0.86	9
Upfront costs are too high	2.4	11.9	28.6	45.2	11.9	3.53	0.94	10
BIM can streamline the procurement process	2.4	4.8	40.5	45.2	7.1	3.50	0.80	11
BIM potentially removes many mundane elements of traditional quantity surveying	7.1	11.9	23.8	42.9	14.3	3.45	1.11	12
There is a scarcity of available training on BIM	2.4	12.2	39.0	34.1	12.2	3.41	0.95	13
Financial and time commitment from small practices is too large	4.8	19.0	26.2	38.1	11.9	3.33	1.07	14
Organizational inertia prevents the adoption of new BIM	4.8	16.7	35.7	31.0	11.9	3.29	1.04	15
Additional costs of training make BIM prohibitive	4.8	19.0	35.7	28.6	11.9	3.24	1.05	16
BIM is too expensive	4.8	11.9	45.2	33.3	4.8	3.21	0.90	17
Roles and responsibilities of quantity surveyors will change	4.8	35.7	16.7	33.3	9.5	3.07	1.13	18
Quantity surveyors resist the introduction and adoption of BIM	9.5	23.8	26.2	31.0	9.5	3.07	1.16	19
There are problems with legal	-	28.6	47.6	23.8	-	2.95	0.73	20

	1	2	3	4	5	Mean	SD	Rank
ownership of information								
BIM reduces the amount of variations during the construction phase	9.5	26.2	35.7	21.4	7.1	2.90	1.08	21
BIM removes human errors from quantity surveying	9.8	34.1	31.7	17.1	7.3	2.78	1.08	22
There is no client demand for BIM	11.9	31.0	42.9	11.9	2.4	2.62	0.94	23
QS practices are too small to embrace BIM	35.7	21.4	16.7	13.6	2.4	2.38	1.13	24
BIM is only for architects and designers	52.4	23.8	9.5	11.9	2.4	1.88	1.51	25

Respondents tended to agree strongly that software would reduce the time to produce Bills of Quantity (mean=4.21). They tended to agree that BIM would increase the efficiency of quantity surveying (mean=4.02) but would require new skills and knowledge (mean=3.90). They also tended to agree that cost estimation could be improved (mean=3.98), BIM would allow the quantity surveyor to focus on strategic activities (mean=3.76) and promote collaboration between stakeholders (mean=3.95). The Respondents further tended to agree that BIM automates taking off and BoQ production (mean=3.59), can streamline the procurement process (mean=3.50) and potentially removes many mundane elements of traditional quantity surveying (mean=3.45). Respondents tended to disagree strongly that technological developments were for architects and designers only (mean=1.88). They tended to disagree that quantity surveying practices were too small to embrace BIM (mean=2.38). What was noticeable were the large proportions of respondents who had neutral views about several of the issues such as there being problems with legal ownership of information (47.6%), information and communication technologies being too expensive (45.2%) and there being no client demand for BIM (42.9%). These findings might be indicative of their lack of knowledge and experience with new technological advances.

Benefits of BIM

Respondents were presented with eight benefits of BIM to quantity surveying and were asked to indicate their level of agreement on a 5-point Likert scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. Their responses ranked by the means are shown in Table 4.

Table 4. Benefits of BIM to quantity surveying (n=42)

Benefit	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	SD	Rank
Improved efficiency	-	2.4	7.1	40.5	50.0	4.38	0.73	1
Visual aid	-	-	11.9	54.8	33.3	4.21	0.65	2
Standardization of routine tasks	-	4.8	9.5	57.1	28.6	4.10	0.76	3
Co-ordination of all design information	-	2.4	19.0	61.9	16.7	3.93	0.68	4

	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	SD	Rank
Cost plan production	-	2.4	21.4	57.1	19.0	3.93	0.71	5
Accurate measurement	2.4	2.4	23.8	47.6	23.8	3.88	0.89	6
Automatic schedule/program production	-	14.3	23.8	47.6	14.3	3.62	0.91	7
Cost effective and efficient	-	2.4	56.1	29.3	12.2	3.51	0.75	8

The findings suggest that respondents tended to either agree or strongly agree that BIM would benefit quantity surveying in all the ways indicated in Table 4 with means ranging from 3.51 to 4.38. Improved efficiency (mean=4.38) was the most dominant benefit derived from BIM and cost effectiveness and efficiency was the least dominant benefit (Mean=3.51). Of particular interest is that even though most respondents agreed that accurate measurement could be achieved through the use of BIM, this was not the most dominant benefit suggesting that respondents still see this aspect of their activities remaining traditional.

Barriers of BIM

Respondents were presented with eight barriers of BIM to quantity surveying and were asked to indicate their level of agreement on a 5-point Likert scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. Their responses ranked by the means are shown in Table 5.

Table 5. Barriers of BIM to quantity surveying (n=22)

Barriers	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	SD	Rank
High cost/extra capital investment	-	7.3	34.1	41.5	17.1	3.68	0.85	1
Lack of software application interfaces	-	12.2	41.5	31.7	14.6	3.49	0.90	2
Software complexity	-	16.7	28.6	45.2	9.5	3.48	0.89	3
Less familiarity with project	7.3	22.0	26.8	36.6	7.3	3.15	1.09	4
Lack of standards	4.8	19.0	45.2	28.6	2.4	3.05	0.88	5
Liability concerns	4.8	26.2	42.9	14.3	11.9	3.02	1.05	6
Threat to services conventionally provided by quantity surveyors	14.3	35.7	33.3	9.5	7.1	2.60	1.08	7
Removed need for a quantity surveyor	35.7	38.1	9.5	11.9	4.8	2.12	1.17	8

From the findings in Table 5 it is evident that respondents tended to agree that the high cost and extra capital investment involved would be the largest barrier to adopting BIM by quantity surveyors (mean=3.68). They tended to disagree with the perceptions that BIM would remove the need for a quantity surveyor (mean=2.12) or present as a threat to services conventionally provided by quantity surveyors (mean=2.60) suggesting that quantity surveyors have not fully realized the benefits, barriers and applications of BIM and how it could possibly change the roles and responsibilities of quantity surveyors. They were somewhat neutral about the other barriers (means from 3.02-3.49).

Determinants of BIM usage

Respondents were asked to rank the significance of six determinants of the use of BIM in quantity surveying practices in ascending order from 1 to 6 with 1 being most significant. The rankings are shown in Table 6.

Table 6. Determinants of BIM usage (n=42)

Determinants of BIM usage	Mean	SD	Rank
Performance expectancy	3.00	1.67	1
Effort expectancy	3.21	1.32	2
Top management support	3.40	1.77	3
Facilitating conditions	3.90	1.16	4
Social influence	3.98	1.51	5
Individual resistance to change	4.02	1.79	6

From Table 6 it is evident that respondents regarded the degree to which a particular BIM would help individuals attain gains in their employment (Performance expectancy) as the most significant determinant of BIM usage in quantity surveying practices. The degree of ease associated with use of the system (Effort expectancy) was the next most significant determinant. Of the six determinants Individual resistance to change was ranked the lowest.

7. CONCLUSIONS

The study found that the knowledge that quantity surveyors had about BIM, software and innovation was at best rather average. They recognized the most obvious benefits of embracing BIM such as the time taken to produce Bills of Quantities which intuitively they still regard as one of their core services to the construction industry. Similarly, more accurate cost estimation was attractive. Largely because of their lack of knowledge of available technologies they could not comment assertively on many of the issues surrounding the relationship between BIM and quantity surveying. This further resonates with the uncertainty that exists surrounding BIM and its business value and return on investment. They, however, recognized the potential that BIM might have on various somewhat routine activities that quantity surveyors get involved with. The greatest inhibitor to BIM uptake was the perceived high cost and extra capital needed. They disagreed that technological advancements presented threats to their existence or the services that they traditionally offered. What would enhance the uptake of BIM was the individual gains that could possibly be achieved through mundane and tedious tasks becoming easier and quicker. In the main the findings of the study resonated with those of other studies done particular in developing countries.

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