Journal of The Nigerian Institute of Architects (NIAJ)
ISSN: 2315-8913

BIM Innovation in SME Firms: The Impact of Developing Environmental Relationship

Sa'id Alkali Kori[1] and Jonathan David Chong[2]
[1] Building Information Modelling, Africa Initiative, 19, Kaltungo Street, Garki 2, Abuja, Nigeria | Family Homes Funds Nigeria, Central Business District Abuja, Nigeria

[2] Department of Architecture, University of Jos Nigeria
.*Corresponding Author chongj@unijos.edu.ng

Abstract: ***Facilitated by the rapid adoption of Building Information Modelling (BIM) across the globe, the Architecture, Engineering, and Construction (AEC) industry is experiencing a paradigm shift in its routine. Consequently, its adoption has brought a twist in both the environment and business procedures for Small and Medium Enterprise (SME) Architectural firms in developing markets. This can be attributed to the lack of a precise orientation in Environmental Relationship development by the firms. Evaluating how BIM adoption and implementation can be significantly influenced by developing Environmental Relationships, this paper identifies the various strategies that concern the development of Environmental Relationships. Deploying two step analysis for the study, an empirical inquiry was conducted to identify the various indicators of Environmental Relationship and the analysis of their impact on BIM adoption. The empirical inquiry comprised of the research framework and fieldwork data collection, and thus, used the framework to retrieve data from the fieldwork. The data collection instrument was a questionnaire survey with a sample of SME architectural firms in Nigeria. The survey involved administering questionnaires to 317 firms in Nigeria with 198 responses obtained and analyzed. Through the empirical enquiry, it was discovered that there are four critical indicators that determine the role of environmental relationship on BIM innovation, these are; the client system, technology market dynamism, competitive environment, and government and regulatory systems. Using regression analysis, the result indicates that Environmental Relationship development has a significant impact on the adoption of BIM in SME architectural firms. Thus, the better SME architectural firms manage and nurture their Environmental Relationships, the more success those firms can experience in terms of BIM innovation.***

Keywords: BIM; Environmental Relationship Development; BIM Business Value Creation; SME; Architect

1. Introduction

Lu and Sexton (2009) state that an environmental relationship can be defined as a firm's network resources that arise from its interactions with the business environment. The firm's capacity for innovation is impacted by this relationship (Wang et al. 2012). The claim made by Lu and Sexton (2009) that the interaction environment plays a crucial role in influencing the success of innovation in Small and Medium Enterprise (SME) architectural firms operating in the construction sector informs the concept of environmental relationships. The assertion is corroborated by Zahra (1996) and Prajogo (2006), who proposed that a firm's interaction with the external environment can impact its capacity to engage in innovative activities. Wang et al. (2012) asserted that a firm's innovation strategy is significantly impacted by environmental concerns. Therefore, it makes sense to take into account an organization's environmental relationship, which can also be utilized to look into how such a company is adopting building information modeling (BIM). According to Lu and Sexton (2009), this environment can be built on two elements: "the task environment," which is where clients engage with the business, and "the competitive environment," which is where the business competes with other businesses for clients and limited resources. However, according to Bourgeois (1980), the environment can also encompass the interactions between consumers, technology, the marketplace, rivals for resources and markets, and regulating organizations like government agencies, labor unions, and temporary associations. According to Bourgeois (1980), there are three main locations where environmental interaction is emphasized. The first area of concentration is on external parties, including rival businesses, vendors, clients, and oversight organizations. The second area of emphasis is on the characteristics of complexity, dynamism, and munificence that are brought about by external market factors. The manager's perspective on the characteristics of the outside forces is the subject of the third focus. The emphasis shared by all of the aforementioned definitions is on the essential relationship between the environmental relationship and four different but complimentary elements: the competitive environment, the technological market, regulatory groups, and client-related interactions.

Therefore, this study took into account four indicators to contextualize the previously mentioned elements and form predictors of determining the motivation and network resources of SME architectural firms through environmental relationships that can be used to explore the relationship effect on their success in adopting BIM. The client system (as the public and private sectors), the competitive climate, the dynamism of the technological market, and regulatory bodies are these indications. According to this theory, dynamism is defined by Wang et al. (2012) as the rate at which innovation occurs in the market; they compared this idea to that of environmental turbulence or a high-velocity environment. By raising awareness of novel concepts in the surroundings, this level of turbulence can also encourage innovation (Rothenberg and Zyglidopoulos, 2007).

The idea that the client drives innovation in the context of in the literature (Tether and Tajar, 2008), the client system is widely acknowledged, especially in the context of the construction sector (Sexton and Barrett 2004, Brandon and Lu (2009), Kiviniemi (2011), Jaradat, Whyte et al. (2013), and Kiviniemi (2006). This is because the majority of the important information that motivates businesses to implement new practices (Guillén et al. 2002) is shaped by the demands and requirements of clients (Tether and Hipp 2002). According to Brandon and Lu (2009), this is because clients have a big influence on policy reform, both in terms of their projects and their drives, which alters how other people operate. Therefore, the government typically assumes responsibility for using its influence to steer things in a favorable direction as it is a big client. This is also true for the process of adopting BIM, where governments in the majority of nations are the primary forces behind the majority of successful adoption programs (Wong et al. 2009). Wong et al. (2009) gave proof of the beneficial roles that the public and private sectors—as key players in fostering and enabling the adoption of BIM in Finland, Norway, Singapore, and Denmark—have played in these countries. One recent example of how governments might serve as clients driving innovation in the construction industry is the UK's 2016 mandate for the use of BIM. Therefore, it is helpful to take into account the connection between BIM success in the Nigerian sector and clients' interactions with the innovative environment of SME architectural firms.

It has been suggested in the literature that regulatory groups are the driving force behind innovation. This is particularly clear in the UK, where regulations are viewed as facilitators of the industry's broad use of BIM (Succar and Kassem 2015), On the other hand, a study on BIM acceptance in South Korea (Lee, Yu et al., 2013) suggests that regulatory pressure might have a detrimental impact on willingness, which in turn affects sustainability. In addition, Toole (1998) proposed that rules like building codes played a role in the 1990s building industry's conservatism. This claim, however, may now be contested in light of the shift in the regulatory landscape, as seen by the UK's 2011 mandate. Consequently, it makes sense to take regulatory organizations into account as a possible sign of BIM innovation in small and medium-sized architectural businesses.

2. Hypotheses and Sub-Hypotheses: Environmental Relationships

The following theories are suggested for further research in the study:

H61: Through environmental linkages, SME architectural firms' motivation and network resources significantly correlate with BIM Business Value Creation (BBVC).

H60: There is no discernible association between BBVC and the drive and network resources of small and medium-sized architectural companies through environmental relationships.

Sub-Hypotheses: • H8a: Companies that are driven by the client system in an innovative setting to acquire skills and build networks are likely to be successful in BBVC.

• H8b: Businesses who are driven by the dynamism of the technology market and the inventive environment to develop their network and capabilities are more likely to succeed in BBVC.

• H8c: Businesses are more likely to prosper in BBVC if they obtain their network resources and competence from competitiveness in the creative environment.

3. Research Framework - Role of Bim Business Value Creation (BBVC)

This section discusses the dependent variable of the BIM Business Value Creation (BBVC) study. The definition of BIM from a business standpoint and the introduction of the term "business value" in BIM are covered first. The study then goes on to define the term "BBVC" using the literature on IT business value and bases its argument on that area.

According to Vass (2015), the majority of research on assessing business value in the industry concentrates on determining the worth of IT. Others focus on choosing appropriate measures or KPIs to assess and gauge the results of deploying IT, especially to gauge any higher productivity that results from it. This also holds for recent research on BIM and construction management. (Aranda-Mena, Crawford et al. 2009, Barlish and Sullivan 2012, Construction 2014, Vass 2014). For example, Curley (2004) expressly says that a maturity and capability metric is necessary to calculate the commercial value of IT in a company. Succar (2009) and Aranda-Mena, Crawford et al. (2009), who contended that creating business value through BIM is heavily reliant on the unique competencies of enterprises, also support this. According to McGraw-Hill (2009), to generate commercial value, many prosperous companies should invest in ensuring that clients are aware of their BIM capabilities. According to the statements made above (Curley 2004, Kohli and Grover 2008, Daneva et al. 2009), developing IT business value requires a certain level of maturity and skill.

2.1. BIM Maturity and Capability Model

The National BIM Standard Capability Maturity Model (NBIMS-CMM), created in the United States by the National Institute of Building Sciences (NIBS, 2007), was the pioneer in the measurement of BIM success or maturity models in businesses. This has been widely documented in the literature. Eleven essential BIM metrics, such as business process, delivery method, data richness, and information accuracy, make up NBIMS-CMM. Since it just addresses information management, it has come under fire for failing to capture the variety of BIM aspects. Because of its structural restrictions, critics have also questioned its usefulness and use (Succar, 2010These critics' insights and influence were so great that they led to the development of new models that attempted to improve upon NBIM-CMM and offer more optimized models. But now that the UK BIM Task Group has been successful in developing and implementing BIM Level 2 across government departments, new models are emerging to find more accurate ways to measure BIM. Several frameworks have been developed to enhance earlier models, such as the BIM Maturity Matrix (Succar, 2010), the Virtual Design and Construction (VDC) Scorecard (Kam, 2015), and the BIM Maturity Measure (BIMMM) (Ammar et al., 2017). They have added several measurement domains, including as policies, technology, and procedures, to previous metrics to capture far broader aspects of BIM. Coexisting AMs have both individually and jointly contributed to the body of literature that examines BIM.

It is crucial to consider all of the maturity models and capacity indices that are now available for the BIM process in order to construct the BBVC measure based on these diverse models and efforts.

A multitude of models aid in the creation of workable models of BIM maturity and capabilities. Control Objects for Information and Related Technologies are among them. Knowledge Retention Maturity Levels, LESAT (Lean Enterprise Self-Assessment Tool), P3M3 (Portfolio, Programme and Project Management Maturity Model), PCMM® (People Capability Maturity Model), (PM)² (Project Management Process Maturity Model), SPICE (Standardized Process Improvement for Construction Enterprises), Supply Chain Management Process Maturity Model, and BPO (Business Process Orientation Maturity Model) are some of the maturity models that have been identified. Kori and Kiviniemi (2015) examined these models, which are listed in Sher et al. (2012), in relation to BIM in Nigeria and found that most of them had a broad approach and could be used as a foundation for a variety of BIM capabilities. Succar (2009) asserted, however, that there is insufficient distinction made between the concepts of maturity and capability. Accordingly, Succar (2009) created the BIM Maturity Matrix and defines "BIM maturity" as "the quality, repeatability, and degree of excellence within a BIM capability." Succar divided the three stages of BIM capabilities into:

- Object-based modeling;
- Model-based collaboration; and
- Network-based integration.

According to Barlish and Sullivan (2012), an organization's BIM maturity is determined by measuring how well it performs or can function within a given stage. Based on the five maturity levels depicted in Figure 1, this is evaluated. BIM maturity levels across several phases, At the first stage (object-based modeling), for instance, According to Barlish and Sullivan (2012), the BIM maturity level at Stage 1 denoted an organization testing or running pilot projects to determine the benefits of BIM; at that stage, they are at a "ad-hoc" or "defined" maturity level, aiming for further optimization through more testing. Moreover, generic objectives at a level comparable to Figure 1 can be used to assess the organization's BIM maturity level: BIM maturity levels at various phases, Figure 2: The Building SMART Alliance's BIM Capability Maturity Model is comparable to Bew and Richards' (2008) BIM Maturity Map in BIM Overlay to the RIBA Outline Plan of Work (Sinclair 2012), or a matrix of competencies. Comparing the BIM business cases of different organizations should take into account their differing levels of maturity.

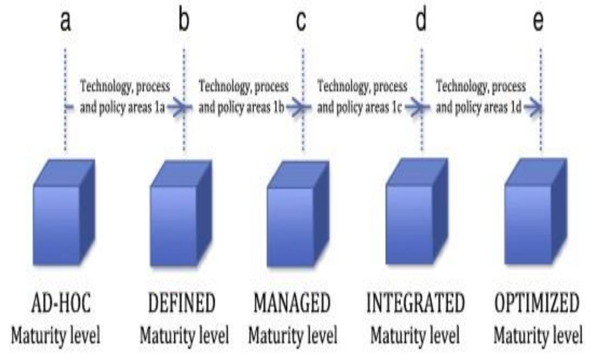

Figure 1: BIM maturity levels at different stages (Barlish and Sullivan 2012)

Thus, after identifying the BIM fields following Bew and Richards' (2008) BIM Maturity map, Succar (2009) further established five levels that outline competence milestones. According to Succar (2009), BIM capability is the fundamental capacity to carry out an operation, provide a service, or produce a good. The fundamental benchmarks that teams and organizations must meet when they implement BIM technologies and concepts are outlined in BIM capability phases, also known as BIM stages. A fixed beginning point (the state before BIM adoption), three fixed BIM stages, and a variable ending point—which accommodates unanticipated future technological advancements—are all identified by the BIM stages. The Succar and Kassem (2015) BIM

Maturity Matrix, which is then utilized as the baseline in establishing the measure of BBVC for this study, is broken down into the following list and description of each of the five stages.

Status before BIM: haphazard project delivery Adversarial interactions and contractual arrangements that promote risk avoidance and risk-shedding are characteristics of the construction sector. A lot of reliance is made on 2D documentation to explain 3D reality. Even in cases when some 3D visualisations are produced, they are frequently incomplete and dependent on two-dimensional details and documentation. Specifications, quantities, and cost estimates are not taken from the documentation or connected to the visualisation model. Likewise, there is no priority placed on stakeholder collaboration, and the workflow is asynchronous and linear. The sector suffered from poor technological investment and a lack of interoperability before BIM.

Object-Based Modeling in BIM Stage 1: Stage 1 collaborative procedures are comparable to pre-BIM conditions, and there aren't many notable model-based exchanges between disciplines. Stakeholders in the project exchange unidirectional data, and communications remain fragmented and asynchronous. Since Stage 1 process alterations are only minimal, pre-BIM contractual agreements, risk allocations, and organizational behavior remain in place. The semantic nature of object-based models and their "hunger" for early and detailed resolutions of design and construction challenges encourage the "fast-tracking of project lifecycle phases"—a method in which a project is still carried out in phases but design and construction activities are overlapped to save time.

Stage 2 of BIM: Model-Based Cooperation Roles, disciplines, and lifecycle stages are divided by pre-BIM demarcation lines, but communication amongst BIM participants remains asynchronous. When document-based processes are supplemented and eventually replace by model-based interchanges, several contract modifications become required. As higher-detail construction models advance and partially or completely replace lower-detail design models, Stage 2 likewise modifies the level of modeling at each lifecycle phase.

Network-Based Integration (BIM Stage 3): Semantically rich integrated models are developed, shared, and managed cooperatively throughout project lifecycle stages at this capability stage. 'Model server' technologies (in proprietary, open, or non-proprietary formats), cloud computing, distributed federated databases, single-integrated databases, or SaaS (Software as a Service) can all be used to accomplish this integration. Early in the virtual design and construction process, comprehensive analyses are possible because of the transdisciplinary nD models that BIM Stage 3 models develop. Presently, model deliverables encompass not only semantic features of objects but also business intelligence, green policies, lean building methods, and entire lifecycle pricing. Nowadays, cooperative efforts "spiral iteratively" around a comprehensive, uniform, and accessible data model. From a process standpoint, synchronous exchange of the model and document-based data results in significant overlap between project lifecycle phases, creating a less phase-less process.

Real-time, interdependent models for integrated project delivery. As a long-term view of BIM as a synthesis of domain technology, processes, and policies, this is the most appropriate stage to portray. Compared to "Fully Integrated and Automated Technology," "Integrated Design Solutions," and other more specific terms, this one may be easier for industry members to understand, or ‘nD Modelling, as three prominent examples. The selection of Integrated Project Delivery (IPD) as the goal of BIM implementation is not to the exclusion of other visions appearing under different names. On the contrary, the path from Pre-BIM (a fixed starting point), passing through three well-defined stages towards a loosely defined IPD is an attempt to include all pertinent BIM visions irrespective of their originating sources.

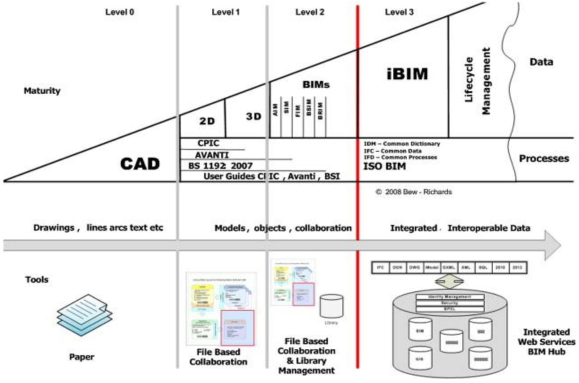

Figure 2: BIM Maturity Map (Bew and Richards 2008)

Similarly, Aranda-Mena, Crawford, et al. (2009) developed a model based on the Val IT approach (ITGI, 2006) and identified three layers of capability:

a) Technical capability: the specific technological capabilities delivered by the program.

b) Operational capability: the operational capabilities that are supported by the technological capabilities.

c) Business capability: the overall business capabilities enabled by the operational capabilities.

The discussion above provided a baseline for shaping an appropriate model that could fit the context of this study. However, because the study deals with SME architectural firms in a Nigerian context, there may be some layers and elements that might need to be re-evaluated and contextualized. Hence, the following discussion will focus on the contextualization of the model.

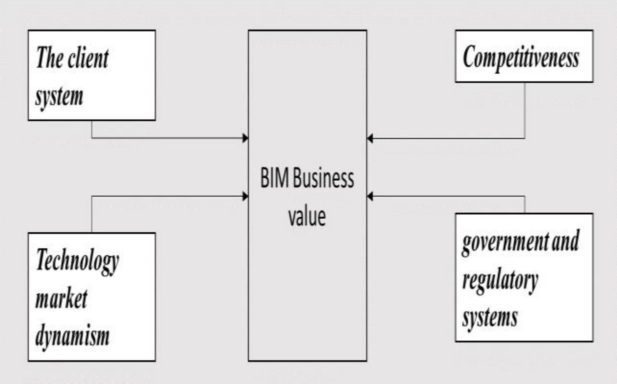

Figure 3: The evaluation Model

4. Analysis

This section presents the analysis of the relationship between motivation and network resources of SME architectural firms through their environmental relationship and BBVC. Table 1 lists the variables of the environmental relationship component.

Table 1: Variables of The Environment Relationship Component

<table>
<tr><th colspan="3">Independent variables</th><th>Dependent variables</th></tr>
<tr><td>Component
Level</td><td colspan="2">The motivation and network resource of SME architectural firms through the environmental relationship</td><td rowspan="5">BIM Business Value Creation (BBVC)</td></tr>
<tr><td rowspan="4">Indicators
Level</td><td>1</td><td>The client system in the innovative environment</td></tr>
<tr><td>2</td><td>The technology market dynamism in the innovative environment</td></tr>
<tr><td>3</td><td>The competitiveness in the innovative environment</td></tr>
<tr><td>4</td><td>The government and regulatory system in the innovative environment</td></tr>
</table>

4.1 Analysis

This section presents the analysis of the relationship between motivation and network resources of SME architectural firms through their environmental relationship and BBVC.

H61: The motivation and network resources of SME architectural firms, through environmental relationships, have a significant correlation with BBVC.

H60: The motivation and network resources of SME architectural firms, through environmental relationships, have no significant correlation with BBVC.

Sub-Hypotheses

- H6a: Firms that derive their capability and network resources through motivation from the client system in the innovative environment are likely to succeed in BBVC.
- H6b: Firms that derive their capability and network resources through motivation from technology market dynamism in the innovative environment are likely to succeed in BBVC.
- H6c: Firms that derive their capability and network resources through motivation from competitiveness in the innovative environment are likely to succeed in BBVC.
- H8c: Firms that derive their capability and network resources through motivation from government and regulatory systems in the innovative environment are likely to succeed in BBVC

4.2 The Regression Analysis

A multiple regression analysis was conducted to investigate whether the motivation and network resources, through the environmental relationship of SME architectural firms toward innovation, have a significant correlation with BBVC. This involved analysing the effect of four environmental relationship indicators in predicting BBVC. Preliminary analysis shows that all assumptions are valid and the potential indicator variables are accepted to carry out the multiple regression analysis.

Table 2I: Model Summary for The Environmental Relationship Component

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.726a	.526	.518	.98870

a. Predictors: (Constant), The government and regulatory system in the innovative environment, The client system in the innovative environment, The technology marketplace in the innovative environment, The competitiveness in the innovative environment

Table 2 shows the multiple linear regression model summary and overall fit statistics. The table shows that the adjusted R^2 of the model is 0.518 with the $R^2 = 0.526$, which means that the linear regression explains 52.6% of the variance in the data.

Table 3: ANOVA Test for The Environmental Relationship Component

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	.798	.172		4.628	.000
The client system in the innovative environment	.602	.065	.598	9.257	.000
The technology marketplace in the innovative environments	-.164	.088	-.175	-1.856	.065
The competitiveness in the innovative environment	.214	.093	.223	2.288	.023
The government and regulatory system in the innovative environment	.112	.085	.113	1.319	.189

a. Dependent Variable: BBVC

b. Predictors: (Constant), The government and regulatory system in the innovative environment, The client system in the innovative environment, The technology marketplace in the innovative environment, The competitiveness in the innovative environment

Table 3 shows the linear regression's F-test, which has the null hypothesis, H60 that there is no linear relationship between the dependent variable and independent variable at the component level (in other words $R^2=0$). The F-test shows a highly significant P-value; thus, the study can assume that the null hypothesis H60 is rejected. Hence, H61 is accepted, which means there is a significant linear relationship between the motivation and network through the environmental relationship of SME architectural firms toward innovation and this has a significant correlation with BBVC at the components level. However, to understand the direct effect, it is essential to conduct further analysis at the indicator level. Hence, the result of the analysis on the indicator level is presented in Table 4.

Table 5 shows the multiple linear regression estimates of all the indicators, thus testing the four sub-hypotheses, H6a-H6d, including the intercept and the significance levels on the effect of each IC indicator on the success of BIM adoption. The Beta (B) value of the unstandardized coefficients shows how much each independent variable affects the dependent variable, BBVC. The table illustrates the likelihood of success in BBVC for enterprises that obtain their network resources and competence from competitiveness in the innovative environment and incentives from the client system. Meanwhile, there is no solid indication of whether BIM adoption will be successful based on technical, government, or regulatory system indications.

Table 4: Coefficient Showing the Linear Regression Estimates of All the Environmental Relationship Indicators of The Components on BBVC

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	242.273	4	60.568	61.960	.000b
	Residual	217.991	223	.978		
	Residual	217.991	223	.978		

a. Dependent Variable: BBVC

5.0 Conclusion

In conclusion, the findings for this section indicate that the development of motivation and networks resulting from RC have a significant impact on BBVC in SME architectural firms. Thus, the better SME architectural firms manage and nurture their RC, and network resources, the more success those firms can experience in terms of BBVC. This network resource is formed through specific critical aspects of the interaction between the firm's internal and external relationships, environment, and image and reputations. For example, within the internal hierarchy, the effective communication flow, encouragement of a participative culture in the innovation process, and less uncertainty avoidance is critical to the development of the network resource.

Another critical aspect in the development of network resources for the BIM adoption process is the aspect of firm interoperability in efficiently operating within the BIM environment. These include technical, semantic, cultural and legal interoperability. Although government and regulatory systems have been proven to play a crucial role in the environmental influence of the BIM adoption process, because there is no clear intervention policy on BIM in Nigeria, only the client system and the competitive environment are critical to BBVC. Additionally, image and reputation, particularly through the outcome quality of BIM and employees' In BIM Business Value Creation, perceptions about one's competitive edge are proven to be crucial.The Aplocate section of the program. Additionally, correctly creating the construction and thermal templates, assigning the templates to the model or models, aligning the models correctly, using Suncast exercises to calculate solar shading, and using ApacheSim for thermal simulation. Finally, extracting results from IES-VE using 'VistaPro' section of the program. The paper in addition indicated aspect of architecture where this methodology is usually applicable. The importance and limitations of this methodology were stressed in this paper. Lastly, it is recommended for future study to explore the processes and procedures of other modules in IESVE software such as daylighting and other modules of IES<VE> that have not been discussed.

References

Aranda-Mena, G., Crawford, J. Chevez, A and Froese, T. (2009). "Building information modelling demystified: does it make business sense to adopt BIM?" International Journal of managing projects in business 2(3): 419-434.

Barlish, K. and Sullivan, K. (2012). "How to measure the benefits of BIM—A case study approach." Automation in construction 24: 149-159.

Bew, M. and Richards, M. (2008). BIM maturity model. Construct IT Autumn 2008 Members' Meeting. Brighton, UK.

Bourgeois, L. J. (1980). "Strategy and Environment: A Conceptual Integration." Academy of Management Review 5(1): 25-39.

Brandon, P. S., and Lu, S.-L. (2009). Clients driving innovation, John Wiley & Sons.

Construction, M. H. (2014). "The Business Value of BIM For Construction in Major Global Markets: how contractors around the world are driving innovation with building information modeling." Smart MarketReport.

Curley, M. G. (2004). Managing Information Technology for Business Value: Practical Strategies for IT and Business Managers (IT Best Practices series), Intel Press.

Guler, I., Guillén, M. F. and Macpherson, J. M. (2002). "Global competition, institutions, and the diffusion of organizational practices: The international spread of ISO 9000 quality certificates." Administrative Science Quarterly 47(2): 207-232.

Jaradat, S., J. Whyte and Luck, R. (2013). "Professionalism in digitally mediated project work." Building Research & Information 41(1): 51-59.

Kiviniemi, A. (2006). "Clients driving innovation: moving ideas into practice." Cooperative Research Centre (CRC) for Construction Innovation

Kiviniemi, A. (2011). "The effects of Integrated BIM in processes and business models." Distributed intelligence in design: 125-135.

Kohli, R. and Grover, V. (2008). "Business value of IT: An essay on expanding research directions to keep up with the times." Journal of the association for information systems 9(1): 23.

Kori, S. i. and Kiviniemi, A. (2015). Towards Adoption of BIM in the Nigerian AEC Industry: Context Framing, Data Collection and Paradigm for Interpretation, http://bimforum.org/wp-content/uploads/2015/05/BIMAS2015Proceedings.compressed.pdf: 34-41.

Lee, S., J. Yu and Jeong D. (2013). "BIM acceptance model in construction organizations." Journal of Management in Engineering 31(3): 04014048.

Lu, S. L. and Sexton, M. (2009). Innovation in Small Professional Practices in the Built Environment, Wiley.

McGraw-Hill (2009). "The Business Value Of BIM. Getting Building Information Modeling to the Bottom Line." Bedford: McGraw Hill Construction.

Prajogo, D. I. (2006). "The relationship between innovation and business performance—a comparative study between manufacturing and service firms." Knowledge and Process Management 13(3): 218-225.

Racheva, Z., Daneva, M. and Sikkel, K. (2009). Value creation by agile projects: Methodology or mystery? International Conference on Product-Focused Software Process Improvement, Springer.

Rothenberg, S. and Zyglidopoulos, S. C. (2007). "Determinants of environmental innovation adoption in the printing industry: the importance of task environment." Business Strategy and the Environment 16(1): 39-49.

Sexton, M. and Barrett, P. (2004). "The role of technology transfer in innovation within small construction firms." Engineering, Construction and Architectural Management 11(5): 342-348.

Sinclair, D. (2012). "BIM overlay to the RIBA outline plan of work." London, UK: RIBA.

Succar, B. (2009). "Building information modelling maturity matrix." Handbook of Research on Building Information Modeling and Construction Informatics: Concepts and Technologies, IGI Global: 65-103.

Succar, B. and Kassem, M. (2015). "Macro-BIM adoption: Conceptual structures." Automation in Construction 57: 64-79.

Succar, B., W. Sher and Williams, A. (2012). "Measuring BIM performance: Five metrics." Architectural Engineering and Design Management 8(2): 120-142.

Tether, B. S. and Hipp, C. (2002). "Knowledge-intensive, technical and other services: patterns of competitiveness and innovation compared."

Technology Analysis & Strategic Management 14(2): 163-182.

Tether, B. S. and Tajar, A. (2008). "Beyond industry-university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base." Research Policy 37(6): 1079-1095.

Ting, H.-F., Wang, H.-B. and Wang, D.-S. (2012). "The moderating role of environmental dynamism on the influence of innovation strategy and firm performance." International Journal of Innovation, Management and Technology 3(5): 517.

Toole, T. M. (1998). "Uncertainty and home builders' adoption of technological innovations." Journal of construction engineering and management 124(4): 323-332.

Vass, S. (2014). A proposed BIM business value model. 30th Annual Association of Researchers in Construction Management Conference, ARCOM 2014; Portsmouth; United Kingdom.

Vass, S. (2015). An Organizational Perspective on the Business Value of BIM, KTH Royal Institute of Technology.

Wong, A., Wong, F. K. and Nadeem, A. (2009). Comparative roles of major stakeholders for the implementation of BIM in various countries. Proceedings of the International Conference on Changing Roles: New Roles, New Challenges, Noordwijk Aan Zee, The Netherlands.

Zahra, S. A. (1996). "Technology strategy and financial performance: Examining the moderating role of the firm's competitive environment." Journal of Business Venturing 11(3): 189-219.