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Measures for Improving Building Information Modelling adoption in Small and Medium-Sized Enterprises in the Nigerian Construction Industry

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ABSTRACT

The sustainable growth of small and medium-sized enterprises in the construction industry depends on adopting modern technologies such as building information modelling (BIM). Improving BIM adoption in construction SMEs is crucial for the construction industry's overall development. Quantitative data was collected in a study involving 182 participants out of 200 distributed questionnaires. IBM SPSS 26 was used for descriptive and exploratory factor analysis, with the KMO and Bartlett's tests to assess data reliability. The study identified four key factors from 19 measures to improve BIM adoption in Nigerian construction SMEs: increased knowledge transfer among stakeholders, guiding principles for BIM implementation, enhanced social networks among BIM stakeholders, and supportive policies and incentives. Recommendations include sustained knowledge transfer among construction professionals, government incentives for BIM projects, supportive policies, raising awareness to boost client demand, and training construction stakeholders through professional affiliations.

Keywords: Small and medium-sized enterprises, Building information modelling, Construction industry, Development, Sustainable growth

INTRODUCTION

Building Information Modelling (BIM) is a sophisticated and comprehensive process used in the field of architecture, engineering, and construction (AEC) industry to conceptualise, design, and manage building projects (Hall, 2018). Utilising digital technology, Building Information Modelling (BIM) surpasses conventional design approaches by forming a centralised and intelligent model encompassing diverse construction project aspects (Aziz, Riaz, & Arslan, 2017). According to Gana and John (2014), BIM is increasingly being embraced by construction experts, particularly in more advanced economies (Ibrahim, Ebekozien, Khan, Aigbedion, Ogbaini, & Amadi, 2022). The digital model facilitated by BIM incorporates graphical and non-graphical

data, providing a holistic view of the construction projects from inception to completion (Deng et al., 2021). The process involved in BIM begins with the collaborative input of various project stakeholders, including architects, engineers, builders, quantity surveyors, project managers, as well as clients (Bozoglu, 2016).

Attributes of BIM, such as integration, visualisation, comprehensive data beyond visual depiction, analysis, simulation capabilities, change management, and facilities management, enhance its advantages within construction processes (Chang, Dzeng & Wu, 2018). Through the digitisation and centralisation of project data, BIM amplifies communication, reduces mistakes, and elevates the overall efficiency and efficacy of the construction journey, spanning its inception to completion (Bryde et al., 2013).

Measures of Building Information Modelling Adoption in construction SMEs in the Nigerian Construction Industry

Construction SMEs play a crucial role in the Nigerian construction sector, contributing significantly to innovation, job creation, wealth distribution, and overall industry development (Ali et al., 2017). Small and medium-sized enterprises also introduce diversity in services, products, and solutions, enhancing market competition and stimulating industry growth (Akinlabi & Badiru, 2019). Their agility and responsiveness to market demands enable easy adaptation, fostering resilience and adaptable construction practices (Ali, Nagalingam, & Building Gurd, 2017). Consequently, construction SMEs often source materials and services locally, which supports local suppliers, improve economic activities and contribute to sustainable development (Jiménez, de la Cuesta-González & Boronat-Navarro, 2021).

The adoption of BIM in construction SMEs can further enhance the functions of construction SMEs in the construction industry, providing broader coverage of the services they render (Morledge, Smith, & Appiah, 2021). Although significant obstacles exist regarding the incorporation of BIM in construction SMEs, including issues like an inadequate legal framework for adoption (Ragab & Marzouk, 2021), challenges related to team collaboration, trust deficits, uncertainties regarding ownership, and differences in cultural viewpoints, among other factors (Alreshidi, Mourshed, & Rezgui, 2017). Prioritising the implementation of strategies to facilitate BIM adoption within the Nigerian construction industry's SMEs is of utmost importance. Wang, Gosling, Kumar, and Naim (2017) suggested that a practical approach for implementing BIM within construction companies, particularly SMEs, involves breaking it down into manageable, step-by-step modular processes tailored to their specific requirements.

Building information modelling awareness and education among construction SMEs can be encouraged through focused campaigns, workshops, seminars, and online resources (McAuley, Behan, McCormack, Hamilton, Rebelo, & Lynch, 2020). These efforts can lead to improved comprehension and increased confidence in the adoption of BIM practices within the SMEs in the construction industry (Babatunde, Ekundayo, Adekunle & Bello 2020). Government support via incentives such as tax breaks, grant, and

financial support for BIM adoption by construction SMEs can facilitate the easy adoption of BIM in the Nigerian construction environment (Babatunde et al., 2020). Furthermore, collaboration among professionals could further strengthen the integration of BIM into construction activities, thus expanding BIM adoption coverage in the construction industry (Abubakar, Ibrahim, Kado & Bala, 2014). In addition, the implementation of national or regional BIM policies and standards can foster consistency and interoperability in construction projects (Colabaga Don & Axéll Gholizadeh, 2023). This environment of standardised practices promotes BIM adoption and facilitates smooth integration throughout the construction industry, particularly benefiting construction SMEs in the Nigerian construction industry (Colabaga et al., 2023).

Similarly, motivating clients with the benefits of BIM and establishing platforms for knowledge exchange among Nigerian construction SMEs will cultivate a supportive community and accelerate BIM adoption within the country's construction environment in Nigeria (Amuda-Yusuf, Adebiyi & Isa, 2018). Further research and insights derived from the construction sector can facilitate the development of efficient strategies for implementing BIM within the construction industry, mainly targeting construction small and medium-sized enterprises (Ahuja, Sawhney, Jain, Arif & Rakshit, 2020). Babatunde, Udeaja & Adekunle (2021) opined that prioritising BIM adoption involves a sequence of vital steps. These encompass the implementation of an educational and training initiative, integration of BIM into academic curricula, establishment of comprehensive BIM guidelines and regulations, provisioning of suitable technological resources and infrastructure, mandatory integration of BIM within all procurement procedures and contracts, and ultimately, the formation of a dedicated BIM council (Babatunde et al., 2021). However, massive awareness by BIM professionals, government agencies and non-governmental organisations can serve as a measure to improving BIM adoption by SMEs in the Nigerian construction industry. Provision of legal framework guiding adoption and usage of BIM can facilitate easy adoption of BIM by both large and small construction companies. Consequently, putting in place appropriate policies and guidelines that support BIM implementation by the government should be a priority in developing countries, Nigeria inclusive (Babatunde, Ekundayo, Adekunle & Bello, 2020). According to Ahuja, Sawhney, Jain, Arif, and Rakshit (2020), increased green rating incentives can motivate BIM adoption. Simultaneously, the creation of a national BIM education and research agenda can ensure the establishment of a well-structured organisational BIM framework for effective implementation in construction projects (Ahuja et al., 2020). Mahamadu, Mahdjoubi, and Booth (2013) summarised in their study that the integration of data exchange via cloud storage into BIM can make it more attractive for major construction works. This will also aid data security and intellectual property protection, forming a sustainable legal framework for BIM adoption in the construction industry (Olatunji, 2011). The table below summarises the measures for BIM adoption in SMEs in the Nigerian construction industry.

Table 1. Sample human systems integration test parameters (Author's 2023).

Measures for BIM Adoption in Construction SMEs	Source(s)
Training of professionals on BIM tools	McAuley, Behan, McCormack, Hamilton, Rebelo, & Lynch (2020), Babatunde et al. (2021)
More academic research on BIM	(Ahuja, Sawhney, Jain, Arif & Rakshit, 2020), Babatunde et al. (2021)
Training of construction professionals	McAuley, Behan, McCormack, Hamilton, Rebelo, & Lynch (2020), Babatunde et al. (2021)
Knowledge transfer among professionals	Babatunde et al. (2021), Abubakar, et al. (2014)
Awareness among professionals	McAuley, Behan, McCormack, Hamilton, Rebelo, & Lynch (2020),
Inclusion of BIM in the academic curriculum	Amuda-Yusuf, Adebiyi & Isa (2018), Babatunde et al. (2021)
Professional orientation for BIM usage	Amuda-Yusuf, Adebiyi & Isa (2018)
Provision of adequate supporting infrastructure	Babatunde et al. (2021),
Collaboration among stakeholders	Abubakar, Ibrahim, Kado & Bala (2014)
Development of a national guide for BIM usage	Wang, Gosling, Kumar, and Naim (2017), (Colabaga Don & Axéll Gholizadeh, 2023)
Development of local software	Babatunde et al. (2021),
Provision of relevant policy by the government	Babatunde et al. (2020)
Proper usage implementation	Ahuja et al. (2020), Gu & London (2010)
Provision of affordable social network	Amuda-Yusuf, Adebiyi & Isa (2018)
BIM Data security	Mahamadu, Mahdjoubi & Booth (2013)
Legal support for BIM implementation	Olatunji (2011)
The incentive for BIM usage	Babatunde et al. (2020)
Cloud-based technology adoption for BIM usage	Mahamadu, Mahdjoubi & Booth (2013)

Research Methodology

This study employed a quantitative approach to explore measures for BIM adoption in construction SMEs within the Nigerian construction sector. The investigation delved into BIM by reviewing existing literature on BIM adoption in the construction industry. Additionally, insights were gathered from construction professionals such as architects, builders, engineers, quantity surveyors, estate surveyors, and land surveyors, who possessed substantial experience in Nigerian construction projects and were affiliated with various construction professional organisations in the country. A structured questionnaire was devised using a Likert scale in alignment with the research objectives. Respondents were asked to express their agreement levels concerning barriers to BIM adoption in construction SMEs in Nigeria, using

a scale where five (5) indicated "Strongly Agree" (SA), 4 for "Agree" (A), 3 for "Neutral" (N), 2 for "Disagree" (D), and 1 for "Strongly Disagree" (SD). Employing a purposive quota sampling technique, two hundred (200) questionnaires were distributed, retrieving one hundred and eighty-two (182) responses, reflecting a 91% response rate.

The 182 collected responses were consistent with the recommendations put forth by Kothari (2004). Descriptive and principal component analyses, encompassing percentage, frequency, and standard deviation calculations, were executed on the gathered data using IBM SPSS Statistics version 26. To ascertain the adequacy of the data for exploratory factor analysis (EFA), tests such as Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity were employed. EFA was utilised to distil extensive datasets into manageable components by assessing their interrelationships. Furthermore, Cronbach's alpha test was employed to gauge data reliability and the interconnectedness of variables within each component, in accordance with insights provided by Tavakol and Dennick (2011). Cronbach's alpha test evaluates data consistency within a scale. The obtained data collection instrument reliability was 0.839, surpassing the recommended Cronbach's alpha coefficient threshold of 0.6, as Eiselen, Uys, and Potgieter (2007) advocated. These outcomes substantiate the reliability of the data collection instrument and the responses collected from the field survey. The results of the analysis were presented in tabular format.

Result and Discussion

Table 2 presents the comprehensive descriptive analysis of measures aimed at enhancing BIM adoption within small and medium-sized enterprises in the Nigerian construction industry. Participants were asked to express their agreement levels on a 5-point scale as follows: 1 = Strongly Disagree (SD); 2 = Disagree (D); 3 = Neutral (N); 4 = Agree (A); 5 = Strongly Agree (SA). The ranking of measures for improving BIM adoption among SMEs in the Nigerian construction industry was based on the calculation of mean item scores (MIS) and standard deviation (σ).

Training of professionals on BIM tools was ranked first with (MIS = 4.24; σ = 0.973), more academic research on BIM with (MIS = 4.22; σ = 1.044) ranked second, training of construction professionals with (MIS = 4.21; σ = 1.014) ranked third, knowledge transfer among professionals with (MIS = 4.18; σ = 0.970) emerged fourth-ranked measures to improve BIM adoption. Awareness among professionals with (MIS = 4.18; σ = 1.981), the inclusion of BIM in academic curricula ranked sixth with (MIS = 4.12; σ = 1.053), professional orientation for BIM usage ranked seventh with (MIS = 4.11; σ =0.980), and provision of supporting infrastructure ranked eighth with (MIS = 4.10; σ = 0.981). Adequate infrastructure provision with (MIS = 3.44; σ = 1.191) and collaboration among stakeholders with (MIS = 4.06; σ = 1.047) ranked ninth. Development of a national guide for BIM usage with (MIS = 4.05; σ = 1.018) and development of local software with (MIS = 4.05; σ = 1.010) ranked eleventh measures to improve BIM adoption. Provision of relevant policy by the government (MIS = 4.04; σ = 1.081) and

proper usage implementation with (MIS = 4.04; σ = 1.079) emerged as the thirteenth-ranked measures to improve BIM adoption. Provision of affordable social network with (MIS = 4.03; σ = 1.059) and BIM data security with (MIS = 4.03; σ = 1.064) ranked fifteenth. Legal support for BIM implementation ranked seventeenth with (MIS = 3.99; σ = 1.077), the incentive for BIM usage ranked eighteenth (MIS = 3.91; σ = 1.058) and cloud-based technology adoption for BIM usage ranked nineteenth (MIS = 3.90; σ = 1.057).

Table 2. Measures to improve building information modelling adoption in construction small and medium-sized enterprises (Author's review, 2023).

Measures to improve BIM adoption in construction small and medium-sized enterprises	Mean	σ	Rank
Training of professionals on BIM tools	4.24	0.973	1
More academic research on BIM	4.22	1.044	2
Training of construction professionals	4.21	1.014	3
Knowledge transfer among professionals	4.18	0.970	4
Awareness among professionals	4.14	0.981	5
Inclusion of BIM in the academic curriculum	4.12	1.053	6
Professional orientation for BIM usage	4.11	0.980	7
Provision of supporting infrastructure	4.10	0.981	8
Adequate infrastructure provision	4.06	1.009	9
Collaboration among stakeholders	4.06	1.047	9
Development of a national guide for BIM usage	4.05	1.018	11
Development of local software	4.05	1.010	11
Provision of relevant policy by the government	4.04	1.081	13
Proper usage implementation	4.04	1.079	13
Provision of affordable social network	4.03	1.059	15
BIM Data security	4.03	1.064	15
Legal support for BIM implementation	3.99	1.077	17
The incentive for BIM usage	3.91	1.058	18
Cloud-based technology adoption for BIM usage	3.90	1.057	19

Exploratory Factor Analysis

Table 3 shows the pattern matrix for improving BIM adoption in small and medium-sized enterprises in the Nigerian construction industry. The nineteenth variables are clustered into four factors. Thus, the factors are interpreted based on the inherent relationship between the variables under each factor before assigning a familiar name to the factors. Therefore, Factor 1 is named ***Increase in Stakeholders' BIM Knowledge Transfer;*** Factor 2 is named ***BIM Implementation Strategies Guiding Principles;*** Factor 3 is named ***Increase Social Networks among Stakeholders on BIM;*** Factor 4 is named ***Supportive Policy and Incentives for BIM.*** Yong and Pearce (2013) noted that a 0.40 loading cut-off is considered a significant variable in exploratory factors components based on pragmatic reasons. Thus, the study retained underlying variables with loadings of more than 0.4.

Factor 1: Increase in Stakeholders' BIM Knowledge Transfer

Factor 1 clustered ten variables: BIM data security 99%, cloud-based technology for BIM usage 95%, awareness among professionals 87%, training of construction professionals 78%, knowledge transfer among professionals 81%, training of professionals on BIM tools 77%, provision of supporting infrastructure 67%, legal support for BIM implementation 66%, the inclusion of BIM in the academic curricula 64% and training of construction professionals 60%. The factor variables clustered a cumulative percentage of 53.841 variances.

Factor 2: BIM Implementation Strategies Guiding Principles

Factor 2 clustered two variables: adequate infrastructure provision 91% and proper usage implementation 90%. The factor variables clustered a cumulative percentage of 11.551 variances.

Factor 3: Increase Social Networks among Stakeholders on BIM

Factor 3 clustered two variables: more academic research on BIM 91% and the provision of affordable social networks 90%. The factor variables clustered a cumulative percentage of 6.338 variances.

Factor 4: Supportive Policy and Incentives for BIM

Factor 4 clustered five variables: the incentive for BIM usage 93%, provision of relevant policy by the government 92%, collaboration among stakeholders 84%, the development of local software 64% and the development of a national guide for BIM usage 64%. The factor variables clustered a cumulative percentage of 5.700 variances.

Table 3. Pattern matrix[a].

	Component			
	1	2	3	4
BIM Data security	0.986			
Cloud-based technology adoption for BIM usage	0.946			
Awareness among professionals	0.868			
Training of construction professionals	0.842			
Knowledge transfer among professionals	0.812			
Training of professionals on BIM tools	0.769			
Provision of supporting infrastructure	0.669			
Legal support for BIM implementation	0.657			
Inclusion of BIM in the academic curriculum	0.640			
Professional orientation for BIM usage	0.601			
Adequate infrastructure provision		0.912		
Proper BIM usage implementation		0.900		
More academic research on BIM			0.905	
Provision of affordable social network			0.897	
The incentive for BIM usage				−0.934
Provision of relevant policy by the government				−0.923
Collaboration among stakeholders				−0.840
Development of local software				−0.638
Development of a national guide for BIM usage				−0.636

Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization. a. Rotation converged in 6 iterations.

Table 4. Componenent correlation matrix.

Factor	1	2	3	4
1	1.000	0.042	−0.051	−0.706
2	0.042	1.000	0.251	−0.070
3	−0.051	0.251	1.000	0.039
4	−0.706	−0.070	0.039	1.000

Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.

Discussion of Findings

The first factor, representing 53.811% of cumulative variances, focuses on improving BIM adoption through data security, cloud-based technology, professional awareness, training, knowledge transfer, and legal support. The study findings collaborate with Zupancic, Buhler, Kosta, and Dakhil's (2018) study, which postulated that stakeholders in the construction industry should develop skills, train the existing workforce, and simplify BIM technology for easy adaptation. The second factor emphasises adequate infrastructure provision and proper BIM usage implementation, accounting for 11.551% of total variances. The study finding agrees with Daniotti, Gianinetto, and Della-Torre's (2020) study, which states that integrating technology like BIM into construction operations necessitates strategies that allow stakeholders in the built environment to make choices, prevent mistakes, loss of time, and economic troubles to improve project management. The strategy to enhance construction operations requires collaborative technologies that combine technologies to create a single shared interface between two or more stakeholders.

The third factor, with cumulative variances of 6.338%, highlights the importance of more academic research on BIM and the provision of affordable social networks for enhancing BIM implementation strategies. The study shows that increasing BIM implementation strategies requires up-skilling university lecturers, academic curriculum, and improving student employability to improve BIM adoption (Bataw, 2016; Babatunde et al., 2020). The study findings also emphasise integrating BIM courses into architecture, construction management, and civil engineering academic curricula to improve the awareness of BIM and social networks among construction stakeholders (Sabongi, 2009).

The fourth factor, "supportive policy and incentives for BIM," includes incentives, government policies, collaboration, local software development, and a national guide, contributing to 5.700% of cumulative variances. This factor explains the need for the government to provide incentives for adopting BIM in small and medium construction enterprises in the study area (Zhang et al., 2020). The findings align with Sun, Jiang, Skibniewski, Man and Shen's (2017) study, which states that enabling appropriate legal terms to be put in place by the joint efforts of the government and construction industry can encourage BIM adoption among construction professionals. Babatunde, Udeaja and Adekunle (2020) state that BIM adoption requires a national guide to unify its adoption among construction firms in Nigeria.

The study underscores the significance of government involvement, collaborative technologies, upskilling stakeholders, and establishing policies and incentives to facilitate BIM adoption in the Nigerian construction industry. The findings align with existing literature and emphasise the need for a comprehensive approach to improve collaborative project planning, analysis, and construction management in small and medium-sized enterprises. The identified measures equip stakeholders and construction firms with strategies to integrate BIM tools effectively, fostering knowledge transfer and collaboration for enhanced construction processes. The study's empirical findings support the initial objective, revealing that the improvement measures for BIM adoption receive above-average ratings on a Likert scale, emphasising their importance in advancing construction operations.

CONCLUSION

The literature review outlines strategies for enhancing Building Information Modelling (BIM) adoption in small and medium-sized construction enterprises in Nigeria. These strategies focus on promoting knowledge exchange, skill development, and efficient communication within construction firms. The top-ten variables identified for enhancing BIM adoption encompass professional training, increased academic research, education for construction professionals, knowledge sharing, professional awareness, BIM integration in education, professional orientation, supporting infrastructure provision, robust infrastructure development, stakeholder collaboration, creation of a national BIM usage guide, and development of local software solutions. These measures facilitate effective communication, collaboration, and knowledge transfer, supporting the successful execution of complex construction projects. The study's objective is achieved through exploratory factor analysis, categorizing measures into four factors: enhancing BIM knowledge transfer, establishing guiding principles, fostering social networks, and providing supportive policies for BIM adoption, offering practical directions for future research in promoting BIM adoption in Nigerian construction SMEs.

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REFERENCES

Ahuja, R., Sawhney, A., Jain, M., Arif, M., & Rakshit, S. (2020). Factors influencing BIM adoption in emerging markets–the case of India. International Journal of Construction Management, 20(1), 65–76.

Akinlabi, B., & Badiru, N. (2019). Strategic innovation and entrepreneurship development of selected SMES competiveness in Lagos state, Nigeria. The journal of accounting and management, 9(2), 20–34.

Ali, I., Nagalingam, S., & Building, G. B. (2017). Resilience in SMEs of perishable product supply chains: Enablers, barriers and risks. Production Planning & Control, 28(15), 1236–1250.

Aziz, Z., Riaz, Z., & Arslan, M. (2017). Leveraging BIM and Big Data to deliver well-maintained highways. Facilities, 35(13/14), 818–832.

Babatunde, S. O., Ekundayo, D., Adekunle, A. O., & Bello, W. (2020). Comparative analysis of drivers to BIM adoption among AEC firms in developing countries: A case of Nigeria. Journal of Engineering, Design and Technology, 18(6), 1425–1447.

Babatunde, S. O., Udeaja, C., & Adekunle, A. O. (2021). Barriers to BIM implementation and ways forward to improve its adoption in the Nigerian AEC firms. International Journal of Building Pathology and Adaptation, 39(1), 48–71.

Bozoglu, J. (2016). Collaboration and coordination learning modules for BIM education. J. Inf. Technol. Constr., 21, 152–163.

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). International journal of project management, 31(7), 971–980.

Chang, K. M., Dzeng, R. J., & Wu, Y. J. (2018). An automated IoT visualisation BIM platform for decision support in facilities management. Applied sciences, 8(7), 1086.

Colabaga Don, M., & Axéll Gholizadeh, E. (2023). Standardization Beyond Compliance: A Study on BIM Standardization in the Swedish AEC Industry from a Contractor's Perspective.

Deng, M., Tan, Y., Singh, J., Joneja, A., & Cheng, J. C. (2021). A BIM-based framework for automated generation of fabrication drawings for façade panels. Computers in Industry, 126, 103395.

Gu, N., & London, K. (2010). Understanding and facilitating BIM adoption in the AEC industry. Automation in construction, 19(8), 988–999.

Ibrahim, F. S. B., Ebekozien, A., Khan, P. A. M., Aigbedion, M., Ogbaini, I. F., & Amadi, G. C. (2022). Appraising fourth industrial revolution technologies role in the construction sector: how prepared is the construction consultants?. Facilities, 40(7/8), 515–532.

Jiménez, E., de la Cuesta-González, M., & Boronat-Navarro, M. (2021). How small and medium-sized enterprises can uptake the sustainable development goals through a cluster management organisation: A case study. Sustainability, 13(11), 5939.

Mahamadu, A. M., Mahdjoubi, L., & Booth, C. (2013, December). Challenges to BIM-cloud integration: Implication of security issues on secure collaboration. In 2013 IEEE 5th International Conference on Cloud Computing Technology and Science (Vol. 2, pp. 209–214). IEEE.

McAuley, B., Behan, A., McCormack, P., Hamilton, A., Rebelo, E., & Lynch, S. (2020). Improving the sustainability of the built environment by upskilling SMEs in Building Information Modelling through the Horizon 2020 BIMcert Project. SDAR* Journal of Sustainable Design & Applied Research, 8(1), 6.

Morledge, R., Smith, A. J., & Appiah, S. Y. (2021). Building procurement. John Wiley & Sons.

Olatunji, O. (2011). A preliminary review on the legal implications of BIM and model ownership. Journal of Information Technology in Construction, 16, 687–696.

Wang, Y., Gosling, J., Kumar, M., & Naim, M. (2017). Accelerating BIM adoption in the supply chain. Report for Highways England.