

Assessment of BIM-Based Stakeholder Management Process

Subjects: [Engineering](#), [Civil](#)

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A continuous evaluation of the stakeholder management process can be achieved using definitive key performance indicators (KPIs). An exhaustive literature survey in this direction provided a set of 26 indicators assessed through a questionnaire survey for their possible implications on the stakeholder management process. The survey was conducted among 55 respondents with experience in using building information modeling (BIM) in mega-construction projects.

stakeholder management

key performance indicator

fuzzy synthetic evaluation (FSE)

construction project

1. Introduction

Changing trends in the construction industry have resulted in increased project complexity due to the involvement of numerous stakeholders. It has, therefore, shifted the focus toward the strategies incorporated in managing these stakeholders to evaluate project success ^[1]. It becomes more challenging in the context of mega-construction projects that are long-duration projects and witnesses the association of numerous stakeholders throughout their life span ^[2]. Due to this, the existing parameters for judging projects' success, particularly the iron triangle elements (i.e., time, cost, and quality) ^[3], fail to suffice the success measurement criteria ^[4].

Extending these indicators has brought safety and environmental sustainability into the mix. A detailed look at them essentially prompts their impetus in measuring the satisfaction of different stakeholders, i.e., clients, contractors, local communities, environmental organizations, suppliers, etc. ^[5]. Based on this, numerous studies have been done that have identified several strategies for stakeholder management. These strategies essentially break down into four specific stakeholder management dimensions, i.e., stakeholder identification and categorization, stakeholder communication and collaboration, stakeholder engagement, and stakeholder satisfaction ^{[6][7]}. However, fulfilling these strategies has been challenging, and several studies have focused on identifying specific technological tools and processes that can streamline the stakeholder management processes.

Such studies have posited building information modeling (BIM) as a significant technological tool that can provide the impetus for project stakeholders' management. BIM is explained as a digital model of the building ^[8] that the stakeholders can use in the planning and execution of their work. Its usage is found to play a central role in improving the communication and collaboration of stakeholders, optimizing their engagement, and leading to

elevated satisfaction levels amongst them [9]. For instance, the common data environment (CDE) provided by BIM allows an efficient collaboration and engagement of stakeholders, i.e., the client, designers, and civil and systems contractors, helping obtain an error-free design [10]. Furthermore, by providing a CDE and a comprehensive data repository [11], the use of BIM in projects is envisaged to improve the communication and information flow among the stakeholders. Moreover, the availability of 3-D models helps optimize the project designs, making them energy-efficient through their energy studies [12] and simulations, which prove instrumental in alleviating stakeholder satisfaction.

These instances point toward the role of BIM in the stakeholder management process. However, they do not provide information about the efficiency of the process. They do not establish any benchmarks that can be used to evaluate the stakeholder management process based on some tangible criteria. In addition, there seems to be a lack of definite indicators in the overall stakeholder management literature that can be used to assess the efficiency of the stakeholder management process. Although a study conducted by Oppong and Chan [13] aims to establish a set of 29 indicators for assessing the stakeholder management process in general, these indicators suffer from a few limitations. Primarily, most indicators use a subjective evaluation approach that only tends to assess the stakeholders' satisfaction qualitatively. Indicators such as "better service delivery" and "sustainable life-cycle performance" only highlighted stakeholders' satisfaction. However, they fail to provide insight into the quantitative measures or parameters to evaluate the service delivery or sustainable life-cycle performance.

Moreover, these parameters serve as a post-evaluation mechanism and are considered a "lagging" measure that fails to fulfill the idea of continuous improvement [4]. Furthermore, the specified indicators are not accorded substantive differences in importance levels when used for process evaluation. This makes the evaluation and rectification process challenging as the practitioner fails to redirect resources to concerning areas without such knowledge. In addition, few of the proposed indicators overlap their definitions with the success factors characteristics proposed for stakeholder management in the various studies. For instance, the authors propose "effective communication" as a performance indicator to evaluate customer and client satisfaction. However, effective communication between the stakeholders is often deemed a critical success factor (CSF) for efficient stakeholder management in studies by Molwus, Erdogan [14] and Nguyen, Chileshe [6], etc. The similarity of the developed indicator with the established CSF for stakeholder management fails to fulfill the performance indicator criteria to "have a significant impact on one or more of the CSFs," as specified by Parmenter [15].

2. BIM-Based Stakeholder Management

Studies focused on assessing the role of BIM on stakeholder management are limited and scarce [10]. BIM's impact on stakeholder management revolves around improving communication, collaboration, information availability, coordination, engagement, and decision-making [16]. The ability of BIM models to reduce the differences between designers and manufacturers [17] in the generated final models shows the improved level of engagement it can bring. In addition, the clash detection feature of BIM [10], intertwined with its improved design visualization [18], provides a collaborative platform for numerous stakeholders [19], leading to their efficient engagement. This engagement is further supplemented by the improved levels of collaboration between the stakeholders through the

availability of a common data environment (CDEs) [20], which allows them to update the models and information in real time and identify and rectify any clashes. BIM models can also save and share the project data seamlessly within the stakeholder group [21], leading to better relaying of important information among the stakeholders, thereby reducing conflicts between them. This leads to increased efficiency in various project stages, leading to overall cost reduction [22]. Looking at the advantages of BIM holistically, it can be used as a tool to improve the efficiency of the overall construction process by having implications on the time and cost of the project.

3. Stakeholder Management Process Assessment Indicators in Megaprojects

The construction industry's main focus has been shifted towards improving performance by following the route of continuous improvement for increasing project and business efficiency [23]. Performance indicators are commonly used in construction projects to assess and provide an outlook on the process and project performance via a benchmarking approach [24]. The continuous evaluation of the process performance requires that the traditional measurement indicators be broadened to assess the subprocess in megaprojects, which are pursued with a wider economic, social, and environmental aspiration [25]. This idea led to the diversification of the measurement indices by including the measures of environmental impacts, safety, asset functioning, innovation, stakeholder satisfaction, etc., with the existing productivity and profitability parameters [26][27]. The involvement of stakeholders in fulfilling these performance measures stresses monitoring individual project processes with an eye on efficient stakeholder management.

Based on this, the operation and maintenance costs [28] and monitoring additional budget incurred due to any rework during the execution [8] can be used to evaluate the project's cost efficiency, an indicator of profitability and productivity. Information about the asset function is important as the downtime of the project asset impacts the service, which creates a dent in the project's profitability [29], an indicator of economic performance that reflects stakeholder collaboration [30] and satisfaction. The downtime of the service shows the efficiency of communication between the stakeholders as it reflects the rate of information flow between the operation and maintenance teams about the asset status [31]. Furthermore, the amount of rework during the execution reflects the increase in the project budget and provides insight into the collaboration of stakeholders during the project's design [32]. Similarly, the time required to get the requisite approvals [33] from competent authorities, the total time incurred on the project's design [34], and the reduction in the amount of rework used as an evaluative mechanism to judge the adequacy and efficiency of engaging and collaborating with the project stakeholder [35].

Although the above indicators tend to measure the needs and expectations of stakeholders concerning the economic aspect, quantifying measures for the evaluation of environmental and social aspects is also important, indicating stakeholder satisfaction. For instance, the environmental impacts of the project can be judged by waste generation [36], carbon dioxide emissions [27], and the designs of the project [37] as the sub-parameters, which are reflective of the satisfaction of internal and, importantly, the external project stakeholders. Similarly, safety is an important consideration among the project stakeholders (both internal and external). It can be measured by accident and fatality rates at the project site [38].

These indicators help to judge and understand the process performance level, which impels the management of the overall project [39]. The availability of information on performance indicators can also serve as a check mechanism and database to understand the needs and expectations of the stakeholders of the project [40]. Therefore, a thorough list of indicators has been prepared and is presented in **Table 1** that can help in the holistic evaluation of the BIM-based stakeholder management process.

Table 1. Identified quantitative indicators to assess stakeholder management performance.

No.	Quantitative Indicators (QI)	Mosley and Bubshait [34]	Ingle and Mahesh [41]	Oppong, Chan [13]	Urbinati, Landoni [42]	Stanitsas, Kirytopoulos [35]	Habibi, Kermanshachi [43]	Moradi, Ansari [26]	Lundgren, Bokrantz [28]	Hristov and Chirico [37]	Khazadi, Sheikhkhoshkar [9]	Li, O'Donnell [44]	Goodman, Ackermann [45]	Angelakoglou, Kourtzanidis [27]	Zheng, Baron [33]
QI 1.	Number of external ideas generated with the consultation of stakeholders				✓	✓	✓						✓		✓
QI 2.	Reduction in operation and maintenance costs		✓	✓				✓	✓		✓				
QI 3.	Emissions (carbon dioxide) during the processes			✓		✓		✓		✓		✓			✓
QI 4.	Number of safety incidents on the project site	✓	✓					✓							
QI 5.	The time between shutdown and reoperation in the event of any asset failure	✓						✓							
QI 6.	Number of complaints from the consumers on account of project effectiveness								✓	✓		✓	✓		
QI 7.	Number of design clashes resulting in rework and waste generation	✓	✓	✓		✓	✓	✓	✓	✓					✓
QI 8.	Asset/service downtime	✓						✓	✓						✓
QI 9.	Asset downtime cost	✓		✓					✓						

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QI 10.	Number of unplanned and non-forecast maintenance		✓						✓						
QI 11.	Maintenance cost as a percentage of total service revenue			✓				✓	✓						
QI 12.	Mean time between failure (total operating time/number of failures)		✓						✓						
QI 13.	Cost of rework expressed as a percentage of project completion cost	✓	✓	✓			✓	✓	✓	✓	✓				
QI 14.	Rework/defect rectification time							✓	✓	✓					
QI 15.	Satisfaction of customers with the developed facility					✓			✓	✓			✓	✓	
QI 16.	Number and cost of unplanned maintenance tasks		✓					✓	✓						
QI 17.	On-time work completion		✓		✓					✓	✓	✓			✓
QI 18.	Achieving project designs as per the required aesthetics, visual permeability, density, and height	✓	✓	✓							✓	✓			
QI 19.	Innovations/technological advancements toward saving project costs are expressed as a percentage of project completion cost	✓		✓	✓		✓			✓	✓				
QI 20.	Innovations/technological advancements toward saving project time are expressed as a	✓		✓	✓		✓			✓	✓				

CRITIC-TOPSIS approach. Built Environ. Proj. Asset Manag. 2022. ahead-of-print.

3. Toor, S.-u.-R.; Ogunlana, S.O. Beyond the 'iron triangle': Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. *Int. J. Proj. Manag.* 2010, 28, 228–236.
4. Mellado, F.; Lou, E.C.; Becerra, C.L.C. Synthesising performance in the construction industry: An analysis of performance indicators to promote project improvement. *Eng. Constr. Archit. Manag.* 2019. ahead-of-print.
5. Eyiah-Botwe, E.; Aigbavboa, C.O.; Thwala, W.D. Curbing PPP construction projects' failure using enhanced stakeholder management success in developing countries. *Built Environ. Proj. Asset Manag.* 2020, 10, 50–63.
6. Nguyen, T.H.D.; Chileshe, N.; Rameezdeen, R.; Wood, A. External stakeholder strategic actions in projects: A multi-case study. *Int. J. Proj. Manag.* 2019, 37, 176–191.
7. Oyeyipo, O.; Odeyinka, H.; Owolabi, J.; Ojelabi, R. Factors Promoting Stakeholder Management of Building Projects. *Int. J. Mech. Eng. Technol.* 2019, 10, 42–49.
8. Khanzadi, M.; Sheikhkhoshkar, M.; Banihashemi, S. BIM applications toward key performance indicators of construction projects in Iran. *Int. J. Constr. Manag.* 2018, 20, 305–320.

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	percentage of project completion time															
1	QI 21. Delivery accuracy	✓				✓	✓			✓						
	QI 22. Percentage of design solutions fulfilling environmental standards			✓		✓		✓						✓		
1	QI 23. Change between actual design time and predicted design time	✓									✓					
	QI 24. Time required for the approvals	✓					✓									✓
1	QI 25. Percentage of drawings that are clear, comprehensive, and well-defined						✓	✓								✓
	QI 26. Data privacy and security				✓						✓			✓		

13. Oppong, G.D.; Chan, A.P.C.; Dansoh, A. A review of stakeholder management performance attributes in construction projects. *Int. J. Proj. Manag.* 2017, 35, 1037–1051.
14. Molwus, J.J.; Erdogan, B.; Ogunlana, S. Using structural equation modelling (SEM) to understand the relationships among critical success factors (CSFs) for stakeholder management in construction. *Eng. Constr. Archit. Manag.* 2017, 24, 426–450.
15. Parmenter, D. *Key Performance Indicators: Developing, Implementing, and Using Winning KPIs*; John Wiley & Sons: Hoboken, NJ, USA, 2015.
16. Mani, S.; Ahmadi Eftekhari, N.; Hosseini, M.R.; Bakhshi, J. Sociotechnical dimensions of BIM-induced changes in stakeholder management of public and private building projects. *Constr. Innov.* 2022. ahead-of-print.
17. Mostafa, S.; Kim, K.P.; Tam, V.W.Y.; Rahnamayiezekavat, P. Exploring the status, benefits, barriers and opportunities of using BIM for advancing prefabrication practice. *Int. J. Constr. Manag.* 2018, 20, 146–156.
18. Raouf, A.M.I.; Al-Ghamdi, S.G. Building information modelling and green buildings: Challenges and opportunities. *Archit. Eng. Des. Manag.* 2018, 15, 1–28.
19. Olbina, S.; Elliott, J.W. Contributing project characteristics and realized benefits of successful BIM implementation: A comparison of complex and simple buildings. *Buildings* 2019, 9, 175.
20. Farnsworth, C.B.; Beveridge, S.; Miller, K.R.; Christofferson, J.P. Application, advantages, and methods associated with using BIM in commercial construction. *Int. J. Constr. Educ. Res.* 2015, 11, 218–236.
21. Georgiadou, M.C. An overview of benefits and challenges of building information modelling (BIM) adoption in UK residential projects. *Constr. Innov.* 2019, 19, 298–320.
22. Pittard, S.; Sell, P. *BIM and Quantity Surveying*; Routledge: Abingdon, UK, 2017.

23. Souza, J.P.E.; Alves, J.M. Lean-integrated management system: A model for sustainability improvement. *J. Clean. Prod.* 2018, 172, 2667–2682.
24. Ding, Z.; Wang, J.; Zuo, J.; Gong, W. Key Performance Indicators for Regional Construction Supervision Systems in China. *Eng. Manag. J.* 2017, 29, 179–188.
25. Rothengatter, W. Megaprojects in transportation networks. *Transp. Policy* 2019, 75, A1–A15.
26. Moradi, S.; Ansari, R.; Taherkhani, R. A systematic analysis of construction performance management: Key performance indicators from 2000 to 2020. *Iran. J. Sci. Technol. Trans. Civ. Eng.* 2022, 46, 15–31.
27. Angelakoglou, K.; Kourtzanidis, K.; Giourka, P.; Apostolopoulos, V.; Nikolopoulos, N.; Kantorovitch, J. From a comprehensive pool to a project-specific list of key performance indicators for monitoring the positive energy transition of smart cities—An experience-based approach. *Smart Cities* 2020, 3, 705–735.
28. Lundgren, C.; Bokrantz, J.; Skoogh, A. Performance indicators for measuring the effects of Smart Maintenance. *Int. J. Product. Perform. Manag.* 2021, 70, 1291–1316.
29. Tripathi, K.K.; Hasan, A.; Neeraj Jha, K. Evaluating performance of construction organizations using fuzzy preference relation technique. *Int. J. Constr. Manag.* 2021, 21, 1287–1300.
30. Li, Y.; Sun, H.; Li, D.; Song, J.; Ding, R. Effects of Digital Technology Adoption on Sustainability Performance in Construction Projects: The Mediating Role of Stakeholder Collaboration. *J. Manag. Eng.* 2022, 38, 04022016.
31. Zhao, J.; Feng, H.; Chen, Q.; Garcia de Soto, B. Developing a conceptual framework for the application of digital twin technologies to revamp building operation and maintenance processes. *J. Build. Eng.* 2022, 49, 104028.
32. Do, S.T.; Nguyen, V.T.; Dang, C.N. Exploring the relationship between failure factors and stakeholder coordination performance in high-rise building projects: Empirical study in the finishing phase. *Eng. Constr. Archit. Manag.* 2022, 29, 870–895.
33. Zheng, L.; Baron, C.; Esteban, P.; Xue, R.; Zhang, Q.; Yang, S. Using leading indicators to improve project performance measurement. *J. Syst. Sci. Syst. Eng.* 2019, 28, 529–554.
34. Mosley, J.C.; Bubshait, A.A. Investigative study of project procurement methods and project performance indicators in Saudi Arabia. *Int. J. Constr. Manag.* 2021, 21, 845–857.
35. Bakhshi, S.; Chenaghlou, M.R.; Pour Rahimian, F.; Edwards, D.J.; Dawood, N. Integrated BIM and DfMA parametric and algorithmic design based collaboration for supporting client engagement within offsite construction. *Autom. Constr.* 2022, 133, 104015.
36. Stanitsas, M.; Kirytopoulos, K.; Leopoulos, V. Integrating sustainability indicators into project management: The case of construction industry. *J. Clean. Prod.* 2021, 279, 123774.

37. Hristov, I.; Chirico, A. The role of sustainability key performance indicators (KPIs) in implementing sustainable strategies. *Sustainability* 2019, 11, 5742.
38. Jin, R.; Zou, P.X.W.; Piroozfar, P.; Wood, H.; Yang, Y.; Yan, L.; Han, Y. A science mapping approach based review of construction safety research. *Saf. Sci.* 2019, 113, 285–297.
39. Radovanović, D.; Holst, C.; Belur, S.B.; Srivastava, R.; Hounghonon, G.V.; Le Quentrec, E.; Miliza, J.; Winkler, A.S.; Noll, J. Digital literacy key performance indicators for sustainable development. *Soc. Incl.* 2020, 8, 151–167.
40. Chinyio, E.; Olomolaiye, P. *Construction Stakeholder Management*; John Wiley & Sons: Hoboken, NJ, USA, 2009.
41. Ingle, P.V.; Mahesh, G. Construction project performance areas for Indian construction projects. *Int. J. Constr. Manag.* 2022, 22, 1443–1454.
42. Urbinati, A.; Landoni, P.; Cococcioni, F.; De Giudici, L. Stakeholder management in open innovation projects: A multiple case study analysis. *Eur. J. Innov. Manag.* 2021, 24, 1595–1624.
43. Habibi, M.; Kermanshachi, S.; Rouhanizadeh, B. Identifying and measuring engineering, procurement, and construction (EPC) key performance indicators and management strategies. *Infrastructures* 2019, 4, 14.
44. Li, Y.; O'Donnell, J.; García-Castro, R.; Vega-Sánchez, S. Identifying stakeholders and key performance indicators for district and building energy performance analysis. *Energy Build.* 2017, 155, 1–15.
45. Goodman, M.S.; Ackermann, N.; Bowen, D.J.; Thompson, V. Content validation of a quantitative stakeholder engagement measure. *J. Community Psychol.* 2019, 47, 1937–1951.

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