

Navigating challenges in information management for sustainable construction project delivery

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<p><i>Article history:</i> Received October 16, 2025 Received in revised form Dec. 08, 2025 Accepted February 14, 2026 Available online March 01, 2026</p> <p><i>Keywords:</i> Building information modelling Construction project sustainability Information management Knowledge management Project management</p> <p>*Corresponding author: Opeoluwa Akinradewo Department of Quantity Surveying and Construction Management, Faculty of Natural and Agricultural Sciences, University of the Free State, Bloemfontein, 9300, South Africa Email: AkinradewoOI@ufs.ac.za ORCID: https://orcid.org/0000-0002-4462-0960</p>	<p><i>Given its complexity and dynamic nature, the construction sector is beginning to understand how important it is to have efficient information management in order to improve sustainability practices. This study aims to examine the challenges that information management faces in the course of advancing sustainability in the South African construction industry. With the use of structured questionnaires, data were gathered quantitatively from 209 experts, including project managers, engineers, and architects. The study employed mean item scores and exploratory factor analysis (EFA) to identify crucial elements influencing the implementation of information management systems in construction projects. The findings revealed three primary challenges to effective information management which include technical factors, human factors, and legal and security issues. The results provide valuable insights for industry stakeholders, offering guidance on addressing these challenges to achieve more sustainable construction practices</i></p>

Introduction

In the twenty-first century, data management should be considered a basic organizational procedure. By exchanging data throughout all organizational components or departments, data management enables businesses to operate more efficiently (Penn and Pennix 2017). High-quality construction projects need extensive, carefully thought-out data processing (Larsson, Eriksson,

and Pesämaa 2018). Notably, organizations have a plethora of choices to effectively automate, develop, and disseminate knowledge thanks to the methodical administration of construction information. A particular construction information system can only be implemented successfully when resources and knowledge are managed efficiently (Yew Wong 2005). Given the construction industry's singular interconnectedness with the economy and society



at large, the need for investing in information management goes beyond just increasing efficiency (Feng et al. 2017). Planning, building, and managing a country's built assets may be done much more effectively and efficiently with the use of information management (Mêda et al. 2021).

Using technology devices for construction processes and sustainability evaluation of projects has received a lot of attention from researchers and major participants in the construction industry recently (Olawumi, Chan, and Wong 2017). To better choose and acquire inexpensive, environmentally friendly building materials for different building designs, Akanmu, Asfari, and Olatunji (2015) developed a decision support system (DSS). In addition, Aksamija (2012) demonstrated how to use BIM analytic tools to model the energy performance of a building in a case study project. Hence, Adamus (2013) found that BIM might help the construction sector achieve the new sustainability requirements by making it easier to simulate and analyze building models for sustainability prior to construction taking place on site. Notwithstanding these efforts, as demonstrated by the literature; construction projects that aim to use building information modelling (BIM) for sustainability encounter challenges when attempting to integrate the two ideas into a single project (Gu and London 2010).

The challenges of designing intelligent buildings that follow sustainable development (SD) principles and the importance of meeting the three SD pillars were highlighted by Adamus (2013). Gu and London (2010) also noted that different nations have different levels of preparedness in the building sector for new procedures and technologies like BIM. Furthermore, there is a disproportionate amount of knowledge and expertise even among the pioneers of the sustainability evaluation measure and early adopters of BIM (Olawumi and Chan 2018). The general resistance of construction stakeholders to deviate from traditional working practices (Abubakar et al. 2014) and the wide variations in readiness and implementation levels among construction organisations and regions (Redmond et al. 2012) have impeded the adoption of BIM and sustainability in construction projects. Thus, comprehending the various aspects of the difficulties facing construction information management can provide a useful understanding of the reasons behind project abandonment and

delays in the construction process, particularly in developing and underdeveloped nations. This will promote sustainable project management in the construction process.

Information management for sustainable construction project delivery

One of the most exciting, risky, and challenging sectors to work in is construction. Furthermore, the sector has a poor image because a large number of important projects have been known to overspend and miss deadlines (Abdul-Rahman et al. 2021). This highlights how important information management and information processing whether computer-based or traditional/manual are to the construction sector (Olimov and Mamurova 2021). Chen and Kamara (2008) contended that the construction sector is highly dependent based on information obtained from the start to the finish, and that because of this industry's diversity and intensity, information management effectiveness is a key differentiator. In the construction industry, information management pertains to gathering, arranging, and sharing project-related data, such as timetables, cost estimates, and design plans (Skibniewski 2023). For environmentally friendly building projects to be successfully managed, effective information management is essential (Yang and Baldwin 2013).

The use of information management systems to promote green building practices has been the subject of multiple studies. Through the integration of building information modelling (BIM) technology with sustainable design standards, Alsayyar and Jade (2015) developed an innovative model that evaluates the benefits and drawbacks of a planned building throughout the planning and design stages. After being built using a database module, the model was tested on a real-life project. Moreover, BIM is considered by Gilkinson et al. (2015) to be a state-of-the-art design-based technology and process that greatly enhances construction projects over their entire lifespan. According to Adamus (2013), building information modelling (BIM) could assist the construction industry in meeting the growing demand for sustainability by allowing for the analysis and simulation of sustainability in building models before construction begins on-site. To aid in the selection and procurement of cost-effective, environmentally friendly construction materials for a range of building designs, Akanmu, Asfari, and Olatunji (2015)

developed a decision support system (DSS). In addition, [Aksamija \(2012\)](#) demonstrated how to use BIM analytic tools to model the energy performance of a building in a case study project.

In this regard, [Akinade et al. \(2015\)](#) established a set of metrics called a building information model-based deconstructability Assessment Score (BIM-DAS) that can be utilised to select deconstructible building designs. The lack of integration as a plugin in BIM software, however, severely restricts the model's usefulness in actual construction projects. Not only does [Cidik et al. \(2014\)](#)'s information categorisation framework optimise these designs, but it also allows for the completion of a thorough design sustainability analysis, making it ideal for use in a BIM environment for evaluating design alternatives. Building information modelling (BIM) and the Leadership in Energy and Environmental Design (LEED) certification system are combined in a technique created by [Jalaei and Jade \(2015\)](#). In order to guarantee that their projects achieve high LEED ratings, project teams can benefit from this method by making more sustainable selections.

For construction projects to be managed sustainably, structured frameworks are essential. The Sustainable Construction Management Plan (SCMP), which outlines strategies for achieving sustainability through material selection, architectural design, and sustainable delivery measures, is examined by [Mumtaz Ali \(2020\)](#). Throughout the course of the project, these frameworks help project managers approach sustainability issues in a logical manner. According to [Kivilä, Martinsuo, and Vuorinen \(2017\)](#), employing control mechanisms is essential to achieving sustainable project management. Their examination of a large-scale infrastructure project shows that effective management of sustainability issues requires a comprehensive control package that includes sustainable project governance and internal project control. These methods ensure that projects follow sustainability guidelines while upholding a balanced relationship among economic, environmental, and social factors. [Nguyen, Shehab, and Gao \(2010\)](#) made the case in their study that, in order to successfully employ information management in building project sustainability, frameworks that include sustainability evaluations using advanced tools like BIM must be designed and put into place. The author also emphasized how important it is for

information management systems more especially, BIM to be included in order for sustainable building projects to be implemented successfully.

Challenges to information management for sustainable construction project delivery

As shown by several studies, a major obstacle to the broad implementation of information management systems is the scarcity of trained workers ([Chan 2014](#)). If there are no workers to advocate for these technologies, then there is no reason to question whether they will be accepted, according to [Aranda - Mena et al. \(2009\)](#). The author also noted that the incompatibility of various information management programs is a major barrier to its adoption. [Ku and Taiebat \(2011\)](#) state that inadequate interoperability across several programs forces data created in one program to be saved in another rather than exchanged, which goes against the primary purpose of using building information management systems. Several stakeholders and owners have struggled to adopt it because they think the re-entry of information goes against all the potential benefits that IT may bring to project execution ([Nanajkar and Gao 2014](#)). Given the unique nature of the data included in BIM models, legal concerns have emerged around the ownership of the many designs, manufacturing, analysis, and construction information included within them ([Ibrahim and Abdullahi 2016](#)).

The primary barriers to BIM identified by [Gamil and Rahman \(2019\)](#) include budgetary constraints, lack of knowledge, insufficient comprehension of BIM methodology, limited awareness and benefits of BIM, and insufficient government backing. It has been reported by [Adefemi et al. \(2021\)](#) that the construction sector faces several challenges when it comes to implementing information management systems. These include a shortage of trained professionals, inadequate information technology infrastructure to facilitate use, resistance to professional changes within the industry, insufficient education and effort, an absence of standards to direct the adoption of building information modelling (BIM), and an inability to educate professionals in its use and adoption. [Agoras \(2018\)](#) states that there are several issues with continuous BIM interconnection throughout all project phases, difficulties incorporating new kinds of teamwork, inadequate technology assistance, insufficient regulations and standards

for BIM collaboration. Implementing BIM as an information management system is hampered by concerns with data protection and ownership, ineffective BIM education on cooperation, a lack of certified BIM specialists, inadequate expertise, a lack of a shared data environment, and the complexity of BIM tools.

Kineber et al. (2023) summed up the issues holding back the building industry's complete adoption of BIM technology. He mentioned literacy rates in the construction industry, adherence to standards and teamwork, implementation costs, the standardisation challenge, stakeholders' competitive mindsets, contract terms, and corporate culture, were all factors to consider. Alizadehsalehi and Yitmen (2018) emphasised that primary barriers to information systems' use in the construction sector are the the considerable expense of implementation, low awareness, and failure to gain individual knowledge. Sun et al. (2017) categorised these factors as follows: lack of managers' understanding and support; availability and cost of specialised software; and the price of required hardware for upgrades. As noted by Adamus (2013), interoperability is still a major obstacle to using information systems to assess the sustainability aspects of architectural models.

Olawumi et al. (2018) looked into the significant obstacles that construction stakeholders have to overcome in order to incorporate sustainability and BIM practices into the building processes. The key challenges that were identified included the industry's unwillingness to change long-standing practices, the slow adoption of new technologies, a lack of understanding of the processes and workflows required for sustainability and building information modelling (BIM), and an inadequate amount of in-depth expertise and experience. A study conducted by Abubakar et al. (2014) revealed that stakeholders in the construction industry consistently and socially resist innovative advancements in the sector. However, Antón and Díaz (2014) argue that stakeholders have limited awareness and understanding of the application of these technologies.

In his research, Ahmed (2018) uncovered the main problem that has been preventing the construction sector from using information systems. These include a lack of awareness about the technology, high costs of hardware and tools, a difficult initial setup, a shortage of experts, high

maintenance costs, insufficient training, complexity, licensing issues, and traditional methods of contracting. The lack of risk insurances, slow Internet, frequent power outages, and an inappropriate and unprepared construction industry are the least major challenges to its adoption.

Presented below are the barriers to information management derived from the literature: The construction industry uses a lot of data; information stored in digital format may be the subject of legal disputes; data confidentiality; human error; limited internet connectivity; lack of necessary skills; opposition to change at work; high software expenditures; complexity of data; absence of information management tools; and the absence of data standardisation.

Methods

This study used a progressive outlook to investigate the difficulties of managing information in ensuring the long-term viability of construction projects in South Africa. This philosophical approach, which emphasizes gathering data in a format that can be categorized, quantified, or organized, served as the driving force for the application of a quantitative strategy (Creswell 2014). Tan (2022) clarified that this strategy makes systematic use of structured questionnaires. This literature that looks at the challenges of information management in advancing sustainability in the construction sector was carefully used to build the research questionnaire. Its goal was to acquire relevant information from the intended audience. A common method in construction-related research, the strategic use of questionnaires allowed for quick and thorough participant coverage (Akinradewo, Aigbavboa, and Akinradewo 2019). Participants were asked to rate each question using a 5-point Likert scale. The majority of the participants in the study were South African professionals working in the public and commercial sectors who directly implemented or influenced sustainable building practices.

Purposive sampling was used in the study to select individuals who occupy important roles in the construction and decision-making processes, including project managers, architects, engineers, quantity surveyors, and construction managers.

There were 209 questionnaires distributed; 143 of them were returned, yielding a 68.4% response rate. According to Pallant (2020), this response rate is much higher than the generally permissible range of 20–30% for online surveys. Microsoft Excel and SPSS were used to analyse the data, and statistical methods such as mean item scores, frequencies, percentiles, and exploratory factor analysis (EFA) were employed. The application of exploratory factor analysis facilitated the reduction of large datasets into manageable clusters, which made it easier to find the relationships that naturally existed between the factors being studied and the opinions of the participants (Pallant 2020). Based on the Cronbach's alpha coefficient of 0.893, the survey instrument was deemed credible, indicating a high degree of dependability in the information gathered via the questionnaire (Yong and Pearce 2013). This meticulous approach not only pinpointed the primary obstacles but also mapped the connections between the viewpoints of the various stakeholders and the broader consequences for sustainable building practices.

Results and discussion

This section presents the findings of the analysis derived from the conducted survey. The results are presented in the tables and figures below.

Respondent's background information

The participants' background information provides a detailed overview of their professional roles, academic qualifications, and relative years of experience, with the number of projects they have successfully overseen. This data, as presented in table 1, is crucial for understanding the diversity and expertise of the sample population involved in the study. Participants were chosen from a variety of occupations in the building sector. The largest segment of the sample comprised Quantity Surveyors, representing 18.18% of the total. Architects made up 17.48%, followed by Construction Managers at 14.69%, and Electrical Engineers at 13.29%. Civil Engineers and Project Managers each accounted for 11.89% of the participants. This varied professional background ensures a wide perspective on the subject matter. The participants in the study possess notable educational backgrounds, with 34.97% holding a bachelor's

degree, 23.78% possessing a diploma, and 23.08% having an honours degree. 12.59% of the respondents also hold a master's degree, while the remaining 5.59% possess a PhD, indicating a high level of expertise. The respondents' backgrounds in terms of professional experience are quite diverse, with a significant proportion having substantial work experience. Specifically, 38.46% have 6-10 years of experience, while 24.48% have 1-5 years, 23.08% of the respondents have 11-15 years of experience, 9.09% have 16-20 years of experience, and 4.90% have over 20 years of experience. The average experience among the respondents is 9.4 years, providing a comprehensive perspective that encompasses both new and seasoned professionals. Furthermore, the number of projects managed by the respondents highlights their level of involvement in the sector. A significant proportion, 39.86%, have managed 5-6 projects, while 26.57% have managed 3-4 projects, and 16.78% have managed either 1-2 projects or over 8 projects. This diversity of experience and project management expertise adds credibility to the responses, underscoring the respondents' high level of expertise and involvement within the sector.

Table 1. Respondents' background information

Category	Classification	Frequency	Percent	
Profession	Architect	25	17.48	
	Civil Engineering	17	11.89	
	Construction Manager	21	14.69	
	Electrical Engineer	19	13.29	
	Project Manager	17	11.59	
	Electrical Engineer	18	12.59	
	Quantity Surveyor	26	18.18	
	Total	143	100.0	
	Highest academic qualification	Bachelor's Degree	50	34.97
		Diploma	34	23.78
Doctorate		8	5.59	
Honours		33	23.08	
Master's Degree		18	12.59	
Total	143	100.0		
Years of Experience	1 to 5	35	24.48	
	6 to 10	55	38.46	
	11 to 15	33	23.08	
	16 to 20	13	9.09	
	20+ years	7	4.90	
	Total	143	100.0	
	1 to 2	24	16.78	

Category	Classification	Frequency	Percent
Number of projects currently working on	3 to 4	38	26.57
	5 to 6	57	39.86
	Above 8 projects	25	16.78
Total		143	100.0

Mean item score ranking

As depicted in table 2, the primary obstacle is resistance to change at the workplace (MS = 3.91, SD = 0.171), followed by high costs of software (MS = 3.80, SD = 0.193) and complexity of data (MS = 3.75, SD = 0.045). Furthermore, lack of information management tools (MS = 3.73, SD = 0.313) assumes the 4th position, while lack of standardization of data (MS = 3.72, SD = 0.076) and limited internet connectivity (MS = 3.72, SD = 0.201) are tied for the 5th position. Additionally, information security issues (MS = 3.68, SD = 0.167) and the construction industry is data-intensive (MS = 3.68, SD = 0.126) are tied for the 8th position. The lowest-ranked challenge is human errors (MS = 3.42, SD = 0.267).

Table 2. Descriptive analysis for challenges of information management

Challenges	Mean	Std. Deviation	Rank
Resistance to workplace change	3.91	0.171	1
Software' high cost	3.80	0.193	2
Data complexity	3.75	0.045	3
Lack of information management tools	3.73	0.313	4
Lack of standardization of data	3.72	0.076	5
Restricted internet access resulting from construction sites being located in remote areas	3.72	0.201	6
Lacking in required skills	3.69	0.254	7
Information security issues	3.68	0.167	8
The construction industry is data-intensive	3.68	0.126	9
Data stored in digital format may be the	3.61	0.216	10

Challenges	Mean	Std. Deviation	Rank
subject of legal disputes			
Confidentiality of data	3.47	0.108	11
Human errors	3.42	0.267	12

Exploratory factor analysis report

The results of both the Bartlett test and the Kaiser-Meyer-Olkin (KMO) measure are shown in table 3. The structural validity of the measuring scale was examined using the Bartlett test and the Kaiser-Meyer-Olkin (KMO) test. The data is checked for sphericity using Bartlett's test, and the sample adequacy is checked using the KMO measure. A KMO value of 0.895 was generated by the former, whereas 772.55 was the estimated chi-square from the Bartlett test, which yielded a substantial p-value of 0.000 at 145 degrees of freedom. This finding suggests that the scale was valid for its intended purpose, as these tests aim for a KMO value of 0.60 or higher and a p-value less than 0.05 for the Bartlett test (Biasutti and Frate 2017).

Table 3. KMO and Barlett's test for challenges of information management

Kaiser-Meyer-Olkin measure of sampling adequacy		0.895
Bartlett's Test of Sphericity	Approx. Chi-Square	772.55
	df	145
	Sig.	0.000

The percentage of variance in each variable that can be explained by the components that were extracted is shown in table 4 by the communalities. All of the variables start at 1.000, which means they each contribute something different. After extraction, the communalities fall into a range of 0.518 for "Restricted Internet Access" to 0.753 for "Resistance to change at the workplace." This means that the factors adequately explain a substantial amount of the variance in each variable and may be included in the factor analysis.

Table 4. Communalities for challenges of information management

Challenges	Initial	Extraction
Resistance to change at the workplace	1.000	0.753
Lack of required skills	1.000	0.615
Human errors	1.000	0.640
High costs of the software	1.000	0.676

Challenges	Initial	Extraction
Lack of information management tools	1.000	0.736
Lack of standardization of data	1.000	0.595
Restricted internet access resulting from construction sites being located in remote areas	1.000	0.734
Complexity of data	1.000	0.743
Information security issues	1.000	0.592
Confidentiality of data	1.000	0.657
Data stored in digital format may be the	1.000	0.518

Challenges	Initial	Extraction
subject of legal disputes		
Construction industry is data intensive	1.000	0.753

To determine the extracted component, the Kaiser's criterion was used, which recommends keeping components with eigenvalues higher than 1. The table 5 presents the eigenvalues, total variance, as well as individual component variances expressed as a percentage. The results suggest that the data can be reduced to three underlying factors, which explain 62.228% of the variation. The initial component explains 22.662% of the variation and possesses an eigenvalue of 9.496. The following components explain 20.294% and 19.272%, with eigenvalues of 1.381 and 1.287, respectively, for the variance.

Table 5. Total variance explained for challenges of information management

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.496	22.662	22.662	9.496	12.464	12.464
2	1.381	20.294	42.956	1.381	11.512	23.977
3	1.287	19.272	62.228	1.287	10.729	34.705
4	0.924	6.023	68.251			
5	0.905	5.781	74.033			
6	0.903	5.544	79.576			
7	0.902	5.517	85.093			
8	0.890	4.419	89.512			
9	0.842	3.014	92.526			
10	0.708	2.898	95.424			
11	0.635	2.296	97.720			
12	0.555	2.280	100.000			

Extraction method: Principal component analysis

Twelve variables were extracted from the literature and grouped into three categories according to the pattern matrix in table 6. The interactions between the variables within each group provide insight into the significance of the clusters.

Cluster 1 was loaded with a total of five variables, as indicated in table 6. This set of factors were "High Costs" (77.1%), "Lack of Tools" (69.5%), "Lack of Standardization" (57.1%), "Limited Connectivity" (55%), and

"Data Complexity" (49.3%). All these can be observed to relate to technical aspects of information management. Hence, this cluster of factors might be labelled the "Technical Factor"; it significantly affected the efficacy and efficiency of construction information management, accounting for 22.662% of the total variance.

Three variables were loaded onto cluster 2, as shown in table 6. These variables were "Resistance to Change" (78.2%), "Lack of Skills" (71.5%), and "Human Error" (68.4%). All these

can be observed to relate to human aspects of information management. Thus, the cluster of factors can be referred to as the “Human Factor”. Its variance of 20.294% indicates that it has a substantial impact on the effective and efficient administration of information in the construction industry.

Table 6 displays the loading of four factors onto cluster 3. The aforementioned factors were “Security Issues” (90.3%), “Data Confidentiality” (85.2%), “Legal Disputes” (81.1%), and “Data Intensity” (76.9%). All these can be observed to relate to the legal and security aspects of information management. Thus, this group of factors can be referred to as the “Legal and Security Factor”. Its variance of 19.272% indicates that it has a substantial impact on the optimal and productive management of information in the construction industry.

Table 6. Pattern matrix for challenges of information management

Challenges	Component		
	1	2	3
High costs of the software	0.771		
Lack of information management tools	0.695		
Lack of standardization of data	0.571		
Limited internet connectivity due to construction sites being located in remote areas	0.55		
Complexity of data	0.493		
Resistance to change at the workplace		0.782	
Lack of required skills		0.715	
Human errors		0.684	
Information security issues			0.903
Confidentiality of data			0.852
Data stored in digital formatting can be subject to legal disputes			0.811
Construction industry is data intensive			0.769

The findings from the study highlight significant challenges faced in the realm of information management within sustainable construction project delivery, underscoring the multifaceted nature of these issues. The foremost obstacle identified is resistance to change at the workplace, reflecting the construction industry’s

traditional practices and the inherent reluctance to adopt new technologies, as indicated by [Olawumi et al. \(2018\)](#), who emphasized the sector’s slow adoption of innovative practices and technologies. This resistance is compounded by the high costs of software, which aligns with [Gamil and Rahman \(2019\)](#), who noted budgetary constraints as a primary barrier to the implementation of information management systems. Additionally, the complexity of data presents a notable challenge, echoing [Adamus \(2013\)](#), who highlighted interoperability issues that hinder effective information flow and management. The lack of information management tools, as revealed in the study, reinforces the findings of [Chan \(2014\)](#), who identified insufficient infrastructure as a critical barrier to information management in construction. Furthermore, the tied challenges of data standardization and limited internet connectivity speak to the systemic issues within the industry, as discussed by [Agoras \(2018\)](#), who pointed out the lack of established standards for BIM collaboration. Lastly, while human errors were ranked as the least significant challenge, this reflects an underlying issue of insufficient training and the need for improved processes to mitigate risks associated with digital data management, as indicated by [Ahmed \(2018\)](#). Collectively, these findings illustrate the pressing need for strategic interventions to enhance information management practices in the construction sector, facilitating a transition towards more sustainable project delivery methods.

The exploratory factor analysis (EFA) findings provide a comprehensive examination of the challenges in information management within the construction industry, revealing intricate interrelations among various factors categorized into three distinct clusters, each representing critical barriers to achieving sustainability and efficiency in construction project delivery.

Cluster 1, labelled the “Technical Factor,” includes five key variables: high costs of software, lack of information management tools, lack of standardization, limited internet connectivity, and data complexity. This cluster accounts for 22.662% of the total variance, emphasizing the technical barriers that significantly hinder effective information management. High software costs resonate with the findings of [Gamil and Rahman \(2019\)](#), who noted budgetary constraints as a primary obstacle to implementing advanced information

management systems. These costs often deter construction firms from investing in necessary technological upgrades, thereby perpetuating inefficiencies. Additionally, the lack of appropriate information management tools further complicates data handling and project coordination. This challenge is echoed in the literature, where [Chan \(2014\)](#) discusses the inadequacy of existing IT infrastructure, which limits the sector's ability to leverage technology effectively. The factors of lack of standardization and limited connectivity are particularly crucial; they underscore the fragmented nature of information across various platforms, as noted by [Agoras \(2018\)](#). The interoperability issues that arise from these gaps result in difficulties sharing data across different software applications, ultimately undermining the goal of a cohesive information management system. Data complexity, which refers to the intricate nature of construction data and its various formats, adds another layer of difficulty. [Adamus \(2013\)](#) highlights the challenges of managing diverse data sets, emphasizing the need for effective data integration strategies to enhance decision-making and project outcomes.

Cluster 2, characterized as the "Human Factor," comprises three variables: resistance to change, lack of skills, and human error, collectively accounting for 20.294% of the variance. This cluster reveals significant human-centric challenges in the adoption and implementation of effective information management systems. The high loading of resistance to change reflects a well-documented phenomenon in the construction industry, where traditional practices often prevail over innovative approaches. [Olawumi et al. \(2018\)](#) noted that the industry's reluctance to embrace new technologies stems from a deeply ingrained culture that favours established methods, thereby stymieing progress. The lack of skills exacerbates this issue, as many professionals lack the necessary training to utilize advanced information management tools effectively. This finding aligns with [Ahmed \(2018\)](#), who underscores the critical importance of investing in workforce training to equip construction professionals with the skills needed to navigate new technologies. The presence of human error further complicates matters; errors can stem from inadequate training or resistance to adopting new systems, resulting in costly mistakes and inefficiencies. Addressing these human factors is essential for fostering a

culture of adaptability and continuous improvement within the construction workforce.

Cluster 3, identified as the "Legal and Security Factor," includes four variables: security issues, data confidentiality, legal disputes, and the data-intensive nature of the construction industry, accounting for 19.272% of the variance. This cluster highlights the significant legal and security challenges inherent in managing information in the construction sector. Security issues emerged as a primary concern, underscoring the necessity for robust protocols to protect sensitive project data. [Ibrahim and Abdullahi \(2016\)](#) discusses the complexities surrounding data ownership and legal implications associated with the information contained in BIM models, which can lead to disputes if not managed properly. The importance of data confidentiality cannot be overstated, as breaches can compromise project integrity and stakeholder trust. Legal disputes arising from mismanaged data further complicate project delivery, highlighting the need for clear legal frameworks that govern data usage and sharing in construction projects. Finally, the recognition of the construction industry as data-intensive emphasizes the sheer volume of information that must be managed, necessitating sophisticated systems to handle, analyse, and secure this data effectively.

Conclusions

This study has provided a comprehensive analysis of the intricate challenges associated with information management in the construction industry, particularly in the context of sustainable project delivery. The findings reveal that a multifaceted array of challenges impedes the effective management of information, with both technical and human factors playing pivotal roles. Specifically, the research identifies high software costs, lack of appropriate information management tools, absence of standardization, limited internet connectivity, and data complexity as significant technical challenges that hinder operational efficiency. Concurrently, human-centric factors such as resistance to change, insufficient skills among the workforce, and the prevalence of human errors further complicate the landscape of information management. Moreover, legal and security concerns regarding data confidentiality and potential legal disputes

highlight the critical need for robust frameworks governing data use in this data-intensive industry.

To effectively mitigate these challenges, it is essential for construction firms to prioritize investments in advanced information management systems that are tailored to enhance data integration and facilitate seamless communication among stakeholders. This includes the adoption of Building Information Modelling (BIM) technologies and the establishment of standardized protocols to promote interoperability across various platforms. Additionally, fostering a culture of adaptability within organizations is crucial; comprehensive training programs should be developed to enhance the competencies of construction professionals, enabling them to navigate and leverage new technologies proficiently. Furthermore, the establishment of clear legal frameworks and standardized data governance policies will facilitate improved data sharing practices and reduce the likelihood of disputes among stakeholders, thereby fostering a collaborative environment that supports sustainable project outcomes.

One limitation of this study is its reliance on a specific geographical context, which may affect the generalisability of the findings to other provinces within the South African construction industry. Future research should therefore explore the implementation and efficacy of innovative information management systems across other provinces. In particular, investigations into the impact of emerging technologies, such as artificial intelligence and machine learning, on enhancing information management practices hold significant promise. Such research endeavours could provide deeper insights into how these advancements can be harnessed to overcome the identified challenges and further contribute to the sustainability objectives within the construction industry.

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