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Evaluating BIM's Role in Transforming Cash Flow Forecasting Among Construction SMEs: A Saudi Arabian Narrative

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Abstract: This scholarly investigation examines the efficacy of Building Information Modelling (BIM) in enhancing cash flow forecasting (CFF) among construction Small and Medium-sized Enterprises (SMEs) in Saudi Arabia, with a specific focus on fostering innovation for sustainable economic advancement. In so doing, it seeks to strengthen the long-term viability of SMEs within the rapidly growing Saudi construction sector, thereby contributing meaningfully to broader economic goals. A quantitative research methodology was employed, with empirical data gathered through a questionnaire survey administered to one hundred construction stakeholders within Saudi Arabian SMEs. Quantitative data analysis techniques were applied to elucidate key themes and pressing issues in current CFF practices. The findings highlight critical challenges faced by Saudi Arabian SMEs in cash flow management, notably a scarcity of financial resources, a lack of advanced CFF expertise, and resistance to technological adoption. Integrating BIM into CFF processes emerges as an effective solution, addressing these challenges by providing accurate, timely financial data, improving project planning and execution, and enabling more informed decision-making, thereby fostering sustainable business operations. The proposed BIM integration strategy offers a practical roadmap for SMEs to adopt BIM for enhanced CFF, aligning with and advancing the sustainable economic objectives outlined in Saudi Arabia's Vision 2030. By focusing on the unique context of Saudi Arabian construction SMEs and their specific cash flow management challenges, this study enriches the existing literature with substantive insights. It critically illustrates how BIM adoption can transform traditional financial management practices, presenting a robust framework for promoting sustainable economic development through innovation in CFF. Furthermore, these findings have significant implications for other developing economies seeking to leverage technological advancements as drivers of long-term growth.

Keywords: Building Information Modelling (BIM); cash flow forecasting (CFF); construction industry; construction SME; Saudi Arabia

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1. Introduction

Small and medium-sized enterprises (SMEs) play a pivotal role in the construction industry, effectively executing numerous projects within limited financial resources and tight schedules, unlike larger organisations [1]. To enhance project performance and improve financial sustainability, these enterprises utilise various cash flow management (CFM) practices, with cash flow forecasting (CFF) being particularly essential. CFF enables the prediction of cash requirements during a building project, helping to prevent financial shortfalls and ensure project continuity [2]. However, a notable limitation for construction SMEs is their inability to manage multiple projects simultaneously, resulting in the concentration of resources on a single project [3]. This dependency increases their reliance on the successful completion of each project with minimal error in CFF to secure profitability [4].

Conventionally, CFF has relied on mathematical algorithms, though these methods pose challenges, including inadequate planning, communication breakdowns, project delays, poor design, and disruptions in payment processes [5]. In recent years, CFF has evolved from traditional mathematical models towards BIM-enabled models, offering enhanced accuracy and efficiency in financial forecasting [6]. BIM has emerged as a transformative technology in the construction industry, facilitating information creation and management across the project lifecycle [7]. BIM enhances CFF by centralising critical project information, such as contract administration and payment transactions, thereby promoting sustainable and resilient forecasting by ensuring long-term accuracy and efficiency [8]. As noted by [9], BIM integrates cost information with design and scheduling data, allowing stakeholders to track total cost and cash flow information, manage changes, and conduct real-time analysis. This approach supports better financial planning and more informed decision-making compared to intuition or guesswork [9,10].

The construction sector in Saudi Arabia is crucial to the nation's economy, contributing significantly to essential infrastructure such as roads, buildings, bridges, and large-scale structures [10]. CFF in Saudi construction SMEs encounters multiple obstacles that impact their potential for sustainable growth. Previous studies have examined Saudi construction SMEs, CFF, and BIM in isolation. By integrating BIM applications, such as BIM dimensions, Common Data Environment (CDE), and smart contracts for CFF, SMEs can achieve enhanced accuracy, efficiency, and timeliness in forecasting, enabling improved financial planning and more sustainable project outcomes [8,9,11,12]. Further integration of BIM fosters innovation within SMEs and promotes sustainable economic growth in the Saudi construction sector [13].

Despite these benefits, BIM adoption among Saudi construction SMEs remains limited due to technological barriers, limited awareness, and a lack of governmental support [14,15]. This constraint not only hinders financial optimisation but also restricts opportunities to implement sustainable construction and financial practices. Effective BIM implementation could address financial challenges by promoting sustainable financial management practices, such as reducing over-reliance on limited financial resources, optimising cash flow, and ensuring financial planning accounts for long-term economic impacts [16]. Thus, the limited adoption underscores a significant research gap in applying BIM to CFF, particularly within Saudi Arabian construction SMEs. This gap limits understanding of the potential benefits of BIM in enhancing CFF for operational sustainability. Accordingly, this study aims to critically evaluate the role of BIM and its advantages for CFF within the context of Saudi Arabian construction SMEs.

2. Literature Review

2.1. An Overview of the Cash Flow Management in Construction Industry

Cash flow denotes the movement of funds into and out of a construction organisation, a critical factor in ensuring project financial stability and operational continuity [17]. For stakeholders, rigorous cash flow management during project execution is essential [18]. Positive cash flow, fundamentally shaped by cash inflows and outflows, underpins a project's financial viability [19]. Cash inflow, encompassing funds received through payments, loans, and stakeholder investments, strengthens organisational liquidity, whereas cash outflow, driven by costs such as material procurement, wages, and operational expenses, represents the project's financial commitments [19,20]. The effective balance between these flows is thus imperative for sustaining financial health throughout the project lifecycle (refer to Figure 1).

A project with higher cash inflow than outflow indicates a positive net cash flow, signaling financial stability and enhancing risk management through improved financial security [21]. Positive cash flow ensures adequate resources for procurement, enabling projects to proceed without delays and facilitating timely completion. It also fosters strong partnerships, reinforcing trust and reliability between contractors and clients [22].

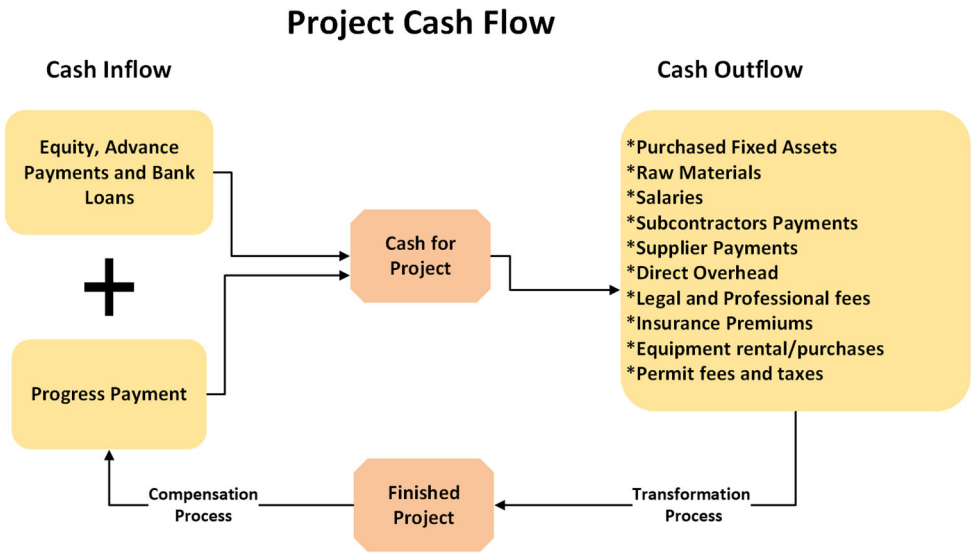

Figure 1. Cash inflow and outflow in a construction project.

Cash flow management, as described by [19], encompasses strategies to balance revenue and expenses while sustaining liquidity. It involves techniques (see Table 1) for forecasting, monitoring, and regulating cash inflows and outflows, as well as addressing any shortfalls during organisational operations.

Table 1. Cash flow management practices used in construction industry.

Cash Flow Management Technique	Description	References
Contingency Planning	Planning for unforeseen circumstances that could negatively affect a construction organization's operations, credibility, or cash flow is crucial. It ensures cash security when anything adverse happens.	[23,24]
Cash Flow Forecasting (CFF)	To prevent the negative effects of debt, anticipate any cash requirements in advance and take the necessary steps to ensure funds are available.	[3,25]
Accounts Receivable Management	Clients or customers owe payments to a construction organization for services provided. It includes any outstanding invoices or bills that the organisation is due payment on but has not yet received.	[26,27]
Earned Value Management (EVM)	EVM integrates measurements of a project's scope, schedule, and resources to assess its achievement and progress. Planned, Earned, and Actual Values are fundamental for EVM. Regular schedules and cost performance assessments allow for accurate projections of completion dates, budgets, and total project costs.	[28,29]

Cash Flow Forecasting and Risks Involved

According to [30], Cash Flow Forecasting (CFF) estimates anticipated inflows and outflows within a specific timeframe, providing critical financial foresight for a business [31]. As construction progresses, project managers can adjust to emerging risks and assess their impacts on cash flow. Throughout the construction phase, CFF functions as a key financial control tool [30]. Traditionally, the construction industry has relied on mathematical CFF models, developed and refined over the years, prior to the adoption of innovative technologies such as BIM-based models. These traditional models incorporate various factors, including project phases, contract terms, payment schedules, timelines, cash flows, time lags, adjustments, and contingencies [32,33].

Nevertheless, numerous risks continue to impact cash flow and operational continuity in construction organisations [34]. A summary of these risks, identified through a literature review, is presented in Table 2.

Table 2. Major risks involved with cash flow forecasting.

S.No	Risks Affecting Cash Flow Forecasting	Description	References
1.	Poor Design	Design issues result in unanticipated costs and disturbed cash flow, which impacts forecasting.	[5,17]
2.	Poor Planning	This may lead to incorrect cash flow forecasts, resulting in a mismatch between anticipated and actual expenditures.	[5,17,35]
3.	Miscommunication	This can result in uncertainty and unanticipated changes in cash flow, hindering forecasts.	[5,21,36]
4.	Scope Changes	Can lead to unexpected expenses, disrupting cash flow predictions.	[5]
5.	Project Delays	This can lead to a delay in anticipated cash inflows and an increase in expenses, leading to imprecise cash flow projections.	[5,35]
6.	Payment Disruptions	Lack of funds or delayed payments can lead to cash flow shortages, which reduce the predictability and efficacy of cash flow forecasts.	[5,35,36]
7.	Insufficient Expertise	Companies may struggle to effectively anticipate their cash flow without sufficient expertise, resulting in possible financial concerns.	[5,17,37]
8.	Ineffective Cash Flow Management	Poor cash flow management can lead to unpredictability in financial conditions, limiting cash flow forecasting accuracy.	[5,17,38]

2.2. Construction SMEs in Saudi Arabia

While there is no universally accepted definition of SMEs within the construction industry [39], construction SMEs are globally acknowledged as essential to economic development, acting as key drivers of innovation, economic growth, employment, poverty reduction, and as vital support for larger organisations [40]. Their relatively smaller scale, compared to larger enterprises, facilitates the adoption of new technologies, as training and upskilling a smaller workforce is often more manageable [41]. This adaptability allows SME managers and owners to implement decisions rapidly and disseminate them swiftly across the organisation.

SMEs are classified differently across countries, with some defining them by employee count and others by annual turnover [40,42]. Table 3 presents an overview of the categorisation of construction SMEs based on [42].

Table 3. SME categorisation across the globe.

Category	Country/Location					
	Europe		Australia		USA	
	Employees	Turnover	Employees	Turnover	Employees	Turnover
Micro	0 to <10	<EUR 2 million	0 to <4	N/A	0 to 20	N/A
Small	10 to <50	<EUR 10 million	5 to <20	N/A	20 to 100	N/A
Medium	50 to <250	<EUR 50 million	21 to <200	N/A	100 to 500	N/A

Construction SMEs in Saudi Arabia are in charge of an abundance of crucial small-scale projects that contribute to implementing Vision 2030 [13]. Given the scope of this initiative, contracting SMEs face significant competition to complete projects within stipulated timescales and achieve financial success effectively [43]. As per [44], SMEs can be classified by sector which is illustrated in following Figure 2.

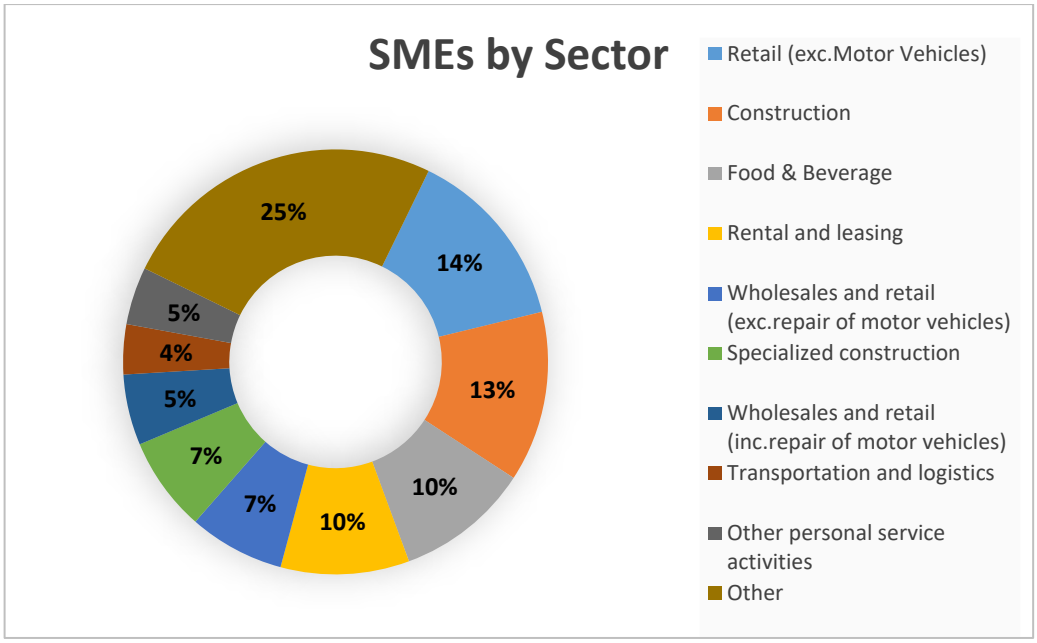

Figure 2. Cash inflow and outflow SME distribution by sector in Saudi Arabia. Adapted from [44].

In Saudi Arabia, the General Authority for Small and Medium Enterprises [44] defines SMEs based on both the number of employees and annual revenue. Specifically, a small enterprise is one that employs between 6 and 49 employees with annual revenues ranging from SAR 3 million to SAR 40 million, while a medium enterprise employs between 50 and 249 employees with annual revenues between SAR 40 million and SAR 200 million. In 2022, construction SMEs, including both specialized and non-specialized entities, comprised 20.2% of all SMEs in Saudi Arabia [14]. Elhassan (2019) [45] reported that Saudi Arabian construction SMEs contribute around 3.2% to the economic activities of all SMEs. Although this is a relatively small percentage, construction SMEs collectively contribute a substantial operating revenue of approximately SAR 171.15 billion (Saudi Arabian Riyal) to the construction industry [16].

Cash Flow Management in SMEs

Construction SMEs face intense competition due to their large numbers, often pushing them to take shortcuts to secure projects [46,47]. Many struggle to implement robust cash flow management (CFM) practices, a challenge compounded by limited access to financing for investments, operations, and new technologies [44]. These constraints are further exacerbated by difficulties in obtaining credit from financial institutions, which frequently perceive SMEs as high-risk borrowers [48]. The inability to manage multiple projects simultaneously can strain operational capacity, as most resources are often dedicated to a single project, resulting in heightened reliance on its successful completion to secure profitability [49]. This dependence makes effective CFM crucial, particularly as SMEs often face delayed payments or lack advance payments from clients, forcing them to front resources to keep projects moving [50].

Managing cash flow throughout the project lifecycle remains one of the most significant challenges for these SMEs, as poor cash flow management can lead to project delays, scope changes, and damaged client relationships. A comprehensive approach to CFM,

including the integration of BIM, is thus essential for enhancing the financial resilience and management capabilities of SMEs.

2.3. Building Information Modelling (BIM)

Building Information Modelling (BIM) is defined as "a digital representation of a facility's physical and functional characteristics and a shared knowledge resource for information about the facility, forming a reliable basis for decisions throughout its lifecycle, from initial conception to demolition" [51]. BIM comprises several dimensions, extending beyond a simple 3D model to provide a visual representation enriched with additional data layers (see Figure 3) [52].

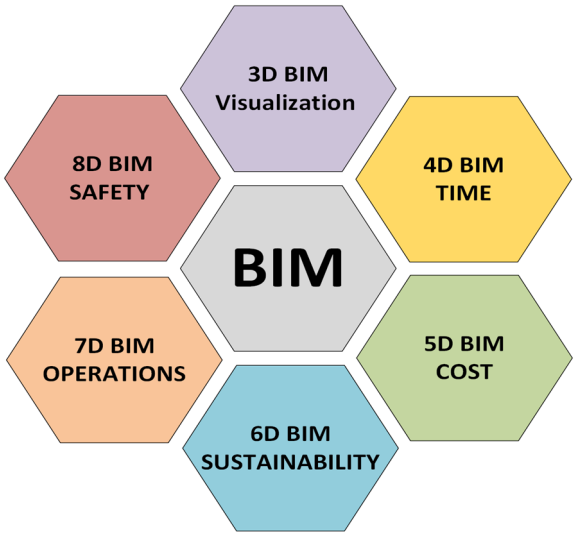

Figure 3. Dimensions of BIM.

The concept of 'nD' modelling reflects BIM's multifaceted capability to incorporate virtually limitless dimensions into the building model, enhancing its utility for comprehensive project analysis [53].

2.4. BIM Applications in Cash Flow Management

Due to recent advancements in construction technologies, BIM has become an integral element in the industry to perform various construction activities [18,54]. While traditionally executed via mathematical methods, recent innovations in construction technology have introduced BIM to support various CFF activities [42], including cost estimation, project scheduling, information management, and multi-party collaboration. To achieve effective CFM, it is essential to complete the project model, schedule, and all cost-related information. This information must then be managed with meticulous care and precision to ensure accurate and reliable CFM.

2.4.1. BIM 4D for Scheduling

As per [55], incorporating time-related information in the 3D BIM model, referred to as 4D BIM, allows for simulation and optimisation of the construction process. This entails utilising specialised software, such as Navisworks 2024 (21.1) or Synchro 4D Pro 2024 (v6.5.4), to connect specific work units or elements represented as objects in the 3D model to construction scheduling activities. This project schedule development aids in creating a project timeline suitable for CFM.

2.4.2. BIM 5D for Cost Information

Cash flow is heavily reliant on accurate cost information to generate payment quantities. The integration of cost information into 4D Models via BIM 5D enables the creation of

a cost model that provides insights into the expenses contractors may face at specific times during a project [19]. Moreover, BIM in construction projects has numerous advantages, including clash detection, increased communication, and better coordination [20]. These benefits lead to fewer variants and reworks, ensuring expenses are within budget. The 5D BIM model outperforms previous approaches in considering design changes, analysing cost and value consequences, and identifying concerns early [20]. It increases efficiency, allows for thorough construction visualisation, and allows for accurate cost estimation.

2.4.3. BIM for Information Management

BIM offers a Common Data Environment (CDE), a centralised repository for construction project information, encompassing project documentation, graphical modelling data, contracts, schedules, and reports [21,56]. Therefore, all CFM-related information can be accessed anytime with the correct authorisation.

The various benefits of BIM significantly contribute to CFM in construction projects. These benefits can be summarized in below Table 4.

Table 4. BIM benefits for cash flow management.

BIM Benefits.	Sources
Enhances accuracy of cost information	[57,58]
Real-time updates to models for any changes	[57,58]
Improves communication and collaboration	[14,54]
Effective decision-making	[59,60]
Improves cash flow monitoring	[57,60]
Enhances resource allocation	[58,61]
Enhances project administration of contract terms	[57,62]
Overall cost-savings	[22]
Improve data handling to improve information management	[28]
Enhances risk mitigation	[63,64]

2.5. BIM Implementation Strategies for Cash Flow Management

Adopting BIM for cash flow forecasting is accompanied by several barriers. High initial costs, limited expertise, insufficient infrastructure, and resistance to change are significant obstacles that make BIM implementation particularly challenging for construction SMEs [42]. The complexity of transitioning to a BIM-integrated environment requires strategic approaches to address these challenges effectively. Consequently, various strategies have been proposed in the literature to support BIM integration within these organisations, particularly in enhancing cash flow management.

Table 5. BIM implementation strategies.

Strategy	Description	Author
Accessibility to affordable BIM training to enhance the workforce	This strategy contributes to enhancing the skills and knowledge of the workforce by making the transition to BIM more seamless. Investing in training helps in overcoming the initial resistance and skill gaps that hinder BIM adoption	[29]
Gradual implementation approach for smoother transition to a BIM-integrated organisation	This entails commencing with minor projects and gradually expanding as the organisation becomes more confident with the technology. This approach effectively mitigates the potential for disruption and financial burden on a construction company.	[11,63]

Table 5. *Cont.*

Strategy	Description	Author
BIM workshops, seminars, and campaigns for clients, owners, and other project stakeholders	Conducting workshops, seminars, and awareness campaigns for clients, owners, and other stakeholders can foster a better understanding of BIM benefits and practices. These educational initiatives are critical in aligning all parties with the objectives of BIM adoption.	[42,63]
Government incentivises industry-wide adoption by providing regulations and policies	Government regulations and policies play a pivotal role in encouraging BIM adoption. Incentives such as tax breaks, grants, and subsidies can alleviate the financial burden on construction organisations, promoting industry-wide BIM integration.	[11,65]
Collaborative partnerships among larger organisations, government entities, and SMEs for knowledge-sharing and mentoring	Forming partnerships between larger organisations, government entities, and facilitates knowledge-sharing and mentorship. These collaborations can provide a construction organisation with access to resources, expertise, and support necessary for successful BIM implementation.	[11,63,65]

The existing literature on this subject reveals a notable scarcity of empirical studies addressing the use of BIM in cash flow forecasting (CFF), particularly within construction SMEs in Saudi Arabia. While extensive research exists on BIM and CFF independently and their roles within the industry, their integrated application remains underexplored. Therefore, this study seeks to provide an empirical analysis to address this gap in knowledge, focusing specifically on the context of Saudi Arabian construction SMEs. Table 5 presents an overview of these strategies.

3. Research Methodology

Building on an extensive literature review that uncovers multiple theoretical perspectives on the research problem, this study adopts a positivist paradigm consistent with the ontological assumption that reality is objective and predetermined. Aligning with the epistemological stance that knowledge exists independently and should be measured through objective means [66], the research maintains a value-free axiology to ensure impartiality.

Research methodologies are broadly classified into qualitative, quantitative, and mixed methods [66–68]. Quantitative methodologies are particularly suited for testing theories, identifying influential factors, and understanding predictors of outcomes [69]. Given the study's aim to investigate the role of BIM in enhancing cash flow forecasting (CFF) among Saudi Arabian construction SMEs and to develop guidelines for BIM-enabled CFF, a quantitative approach is deemed most appropriate. This approach facilitates the examination of relationships posited by existing theories without engaging in the nuanced, contextual understanding that qualitative methods provide [67].

The selection of a quantitative methodology allows for the collection of standardised data through predetermined instruments, enabling statistical analysis to test hypotheses and validate theoretical constructs. This is consistent with a deductive research approach, which begins with hypotheses derived from the existing literature and employs empirical data to confirm or refute these propositions [70]. The structured nature of this approach enhances the ability to generalise findings to a broader population, an essential consideration given the study's focus on SMEs across Saudi Arabia [71].

Moreover, utilising quantitative methods enhances the study's replicability and dissemination. Standardised methodologies enable future researchers to replicate the research design, contributing to the ongoing validation and refinement of theories within the field [72]. This systematic approach not only strengthens the reliability of the findings but also advances the body of knowledge by providing empirical evidence that can inform both academic discourse and practical applications in the construction industry.

Overall, the study's methodological design—rooted in positivism and employing a deductive, quantitative approach—provides a robust framework for objectively investigat-

ing the impact of BIM on CFF in Saudi Arabian construction SMEs. This alignment ensures that the research is conducted with rigour and contributes valuable insights to both theory and practice.

3.1. Data Collection

Quantitative research encompasses several techniques for data collection, including survey, descriptive, experimental, correlational, and causal-comparative methods [73]. Among these, survey research is particularly suitable for this study because it enables generalisation [72]. By posing questions to individuals within a specific group or location, survey research gathers relevant information [73]. This widely used quantitative method allows for the evaluation of numerous characteristics of a target population. Questionnaires, in particular, offer the advantage of providing accurate information cost-effectively and reliably. With thoughtful design, testing, and administration, they can yield both qualitative and quantitative data that are relevant and precise [74].

To collect data on the role of BIM in cash flow forecasting within construction SMEs in Saudi Arabia, an extensive literature review was conducted, compiling pertinent scholarly articles, conference papers, proceedings, and reports. The insights gained from this literature review were subsequently utilised to formulate the survey questions.

The Recruitment of Survey Respondents

As [75] underscores, the accuracy and reliability of research findings are fundamentally contingent upon the precision of data collection; methodological flaws at this stage are irreparable in subsequent analysis. Consequently, meticulous attention was devoted to selecting appropriate data collection methods and sources to ensure the study's integrity. In alignment with the research problem, a purposive sampling strategy was employed. This non-probability sampling technique is particularly effective when research requires insights from specific subgroups possessing relevant expertise [75]. By deliberately selecting participants with profound knowledge of the subject matter, the study aims to elicit rich, pertinent data that directly address the research questions.

A total of 109 industry professionals were identified and invited to participate in the survey. These individuals held pivotal positions such as project managers, BIM managers, BIM coordinators, architects and designers, quantity surveyors, BIM modellers, and construction project planners. The selection criteria were stringent: participants were required to have substantial industry experience within SMEs, demonstrable knowledge of CFF, and proficiency in BIM technologies. Emphasising the SME classification of their organisations ensured that the data collected would be directly applicable to the specific context of the study. Focusing on professionals embedded within construction SMEs was imperative, as it facilitated an in-depth understanding of the unique challenges and opportunities associated with BIM implementation in these entities. By targeting this specific cohort, the research endeavoured to capture nuanced insights that might be overlooked in a broader sample, thereby enhancing the relevance and applicability of the findings to the SME sector.

Of the 109 professionals approached, 100 completed the questionnaire, yielding an exceptional response rate of 91.74%. This high level of participation not only reflects the participants' engagement with the subject matter but also fortifies the statistical validity of the study. The elevated response rate minimises non-response bias, thereby enhancing the reliability of the conclusions drawn. Detailed demographic and professional profiles of the respondents are presented in Table 6, providing a comprehensive overview of the sample's composition.

Despite the advantages of purposive sampling in facilitating a focused investigation, it is acknowledged that this method may introduce limitations concerning the generalisability of findings and the potential for selection bias [76]. Nevertheless, given the exploratory nature of the study and its concentration on a specific industry segment, purposive sampling was deemed the most appropriate methodological choice. To mitigate potential biases

inherent in this approach, deliberate efforts were made to ensure a diverse representation of professional roles, experience levels, and organisational sizes within the SME sector.

Table 6. Profile of questionnaire respondents and the interviewees.

Questionnaire Respondents		
Current Designation	**Frequency**	**Percentage**
Directors/Owners (Construction SMEs)	5	5.00%
Architects	3	3.00%
Project Managers	40	40.00%
Finance Managers	5	5.00%
BIM Engineers	17	17.00%
Site Engineers	2	2.00%
Contract Administrators	2	2.00%
Quantity Surveyors	14	14.00%
QA/QC Professionals	5	5.00%
BIM Modellers	3	3.00%
Researchers	4	4.00%

3.2. Data Analysis

The questionnaire data were analysed using IBM SPSS Statistics 28, employing two analytical methods to provide a comprehensive understanding of rankings and themes through the weighted mean rating (WMR): Descriptive Analysis and Reliability Analysis (using Cronbach's Alpha). Further details on these analytical methods are provided in Sections 4.1 and 4.2 of this study.

4. Research Findings and Discussion

4.1. Demographics

Out of the 109 professionals approached for the survey, 100 responded, yielding a robust response rate of 91.74%. The respondents represented a cross-section of industry experts within Saudi Arabian construction SMEs, encompassing various roles, experience levels, and organizational sizes. As detailed in Figures 4 and 5, the demographic distribution provides a comprehensive overview of the participants, enhancing the reliability of the findings.

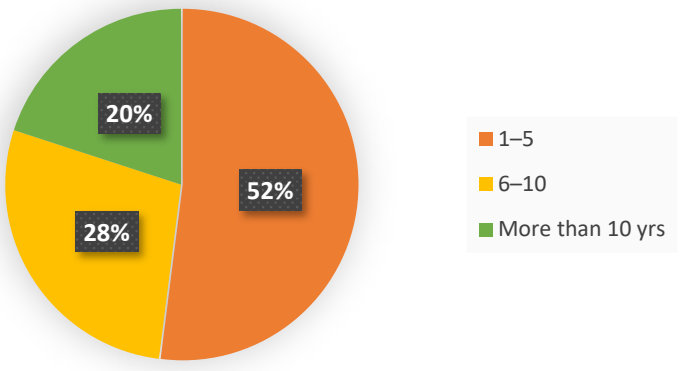

Figure 4. Industry experiences of the involved respondents.

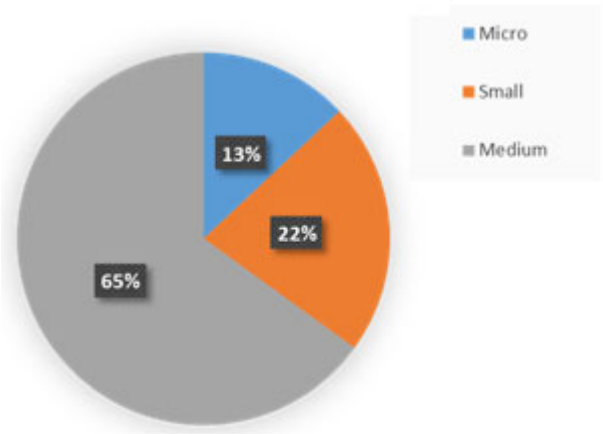

Figure 5. SME category of the involved respondents.

As illustrated in Figure 4, a majority (52%) of the respondents possessed 1–5 years of industry experience, indicating a substantial representation of early-career professionals. Those with 6–10 years and over 10 years of experience accounted for 28% and 20%, respectively. This distribution suggests a balanced mix of fresh perspectives and seasoned expertise, which is critical for a nuanced understanding of BIM and CFF practices in SMEs. Figure 5 demonstrates that 65% of respondents were affiliated with medium-sized organizations, while small-sized (22%) and micro-sized (13%) organizations comprised the remainder. This skew towards medium-sized enterprises reflects the predominant structure of the Saudi construction industry and underscores the relevance of BIM implementation strategies tailored to organizations of varying scales.

4.2. Reliability Analysis Using Cronbach's Alpha

To ensure the internal consistency of the survey instrument, Cronbach's alpha was employed, a statistical measure ranging from 0 to 1 where values above 0.7 are generally considered acceptable [77]. As presented in Table 7, all variables exhibited high reliability coefficients, with values ranging from 0.846 to 0.880. These results affirm that the questionnaire items cohesively measure the underlying constructs pertinent to BIM applications and cash flow forecasting challenges.

Table 7. Reliability analysis using Cronbach's alpha.

No.	Variable	N of Items	Cronbach's Alpha	Mean	Standard Deviation	Skewness	Kurtosis
1	CFF_Prb	10	0.846	3.954	0.74143	−1.297	1.569
2	BIM_App	10	0.880	4.149	0.47645	−0.446	0.171
3	BIM_Strat	5	0.850	4.418	0.50684	−0.947	0.654

The high Cronbach's alpha values across all variables indicate strong internal consistency, suggesting that the survey instrument is both reliable and valid for assessing the perceptions of BIM and CFF among construction SMEs in Saudi Arabia.

4.3. Cash Flow Forecasting Challenges in Construction SMEs

The research delineated ten critical challenges impeding cash flow forecasting (CFF) within Saudi Arabian construction SMEs, with eight identified from the existing literature and two emergent from the survey data. Table 8 presents these challenges ranked by their Weighted Mean Ratings (WMR), offering nuanced insights into the multifaceted obstacles affecting effective CFF.

Table 8. CFF problems WMR and ranking.

Code	Challenge	WMR	Rank
CFF1	Ineffective cash flow management	4.28	1
CFF2	Scope Changes	4.22	2
CFF3	Project Delays	4.22	3
CFF4	Poor Design	4.21	4
CFF5	Poor Planning	4.20	5
CFF6	Payment Disruptions	4.17	6
CFF7	Insufficient Expertise	4.13	7
CFF8	Miscommunication	4.05	8
CFF9	Insufficient Information	4.05	9
CFF10	Lack of Collaboration	4.008	10

The challenges of Insufficient Information (CFF9) and Lack of Collaboration (CFF10) surfaced uniquely from the questionnaire responses, whereas the remaining challenges were corroborated by the literature review. The mean WMRs across all 100 respondents indicate that each challenge significantly impacts organizational CFF, with Ineffective Cash Flow Management (CFF1) being the most critical (WMR = 4.28) and Lack of Collaboration (CFF10) the least (WMR = 4.008). The close proximity of WMR values suggests that all identified challenges exert considerable influence on CFF. Notably, these challenges coalesce into two primary themes: Management and Organizational Issues and Communication and Collaboration, as depicted in Figure 6.

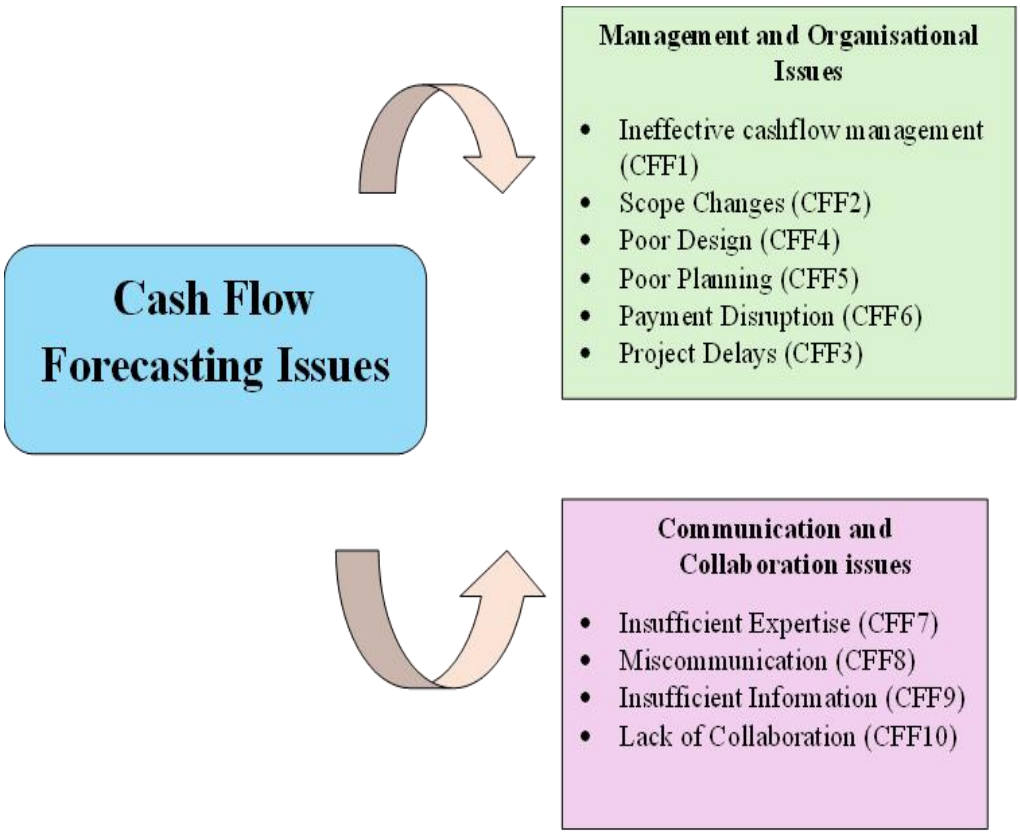

Figure 6. Themes identified in CFF problems [**Source:** Author].

This thematic clustering underscores that Saudi Arabian construction SMEs are grappling with both organizational inefficiencies and project-level management problems that significantly undermine their cash flow forecasting capabilities. Moreover, the interrelated nature of these challenges indicates systemic issues within the industry.

In-Depth Analysis of Key Challenges

***Ineffective Cash Flow Management* (*CFF1*):** Ranking highest, this challenge highlights systemic inefficiencies in managing financial resources. Reliance on outdated estimation models and susceptibility to human error contribute to inaccuracies in cash flow projections [78,79]. The absence of sophisticated financial management tools exacerbates these issues, leading to liquidity problems and financial strain [78]. This underscores a critical need for modernized financial practices and tools to enhance forecasting accuracy.

***Scope Changes* (*CFF2*):** Frequent alterations in project scope disrupt financial planning and strain resource allocation. These changes often originate from evolving client requirements or inadequately defined initial project parameters, culminating in cost overruns and schedule delays [80]. The inability to adapt efficiently to scope changes signifies a pressing need for flexible and dynamic forecasting tools that can accommodate such variability.

***Project Delays* (*CFF3*):** Project delays are frequently a direct consequence of scope changes, and external factors like inefficient material procurement, unfavourable site conditions, approval bottlenecks, fluctuating material prices, and a deficiency in stakeholder expertise [81]. These delays not only inflate costs but also complicate cash flow management by extending project timelines and disrupting scheduled payments.

***Poor Design* (*CFF4*):** Ambiguities or complexities in client objectives can impede contractors' ability to deliver suitable designs. Divergent interpretations among draftsmen further complicate the design process, potentially leading to reworks, scope changes, and legal disputes among stakeholders [82–84]. Such issues amplify project costs and timelines, adversely affecting cash flow forecasts.

***Poor Planning* (*CFF5*):** The absence of a well-defined project timeline undermines the ability to meet client objectives and adhere to contractual obligations. Inadequate scheduling capabilities hinder access to financing from banks or clients, destabilizing financial planning and precipitating further delays and cost reductions [17]. Effective planning is thus essential for accurate cash flow forecasting and financial stability.

***Payment Disruptions* (*CFF6*):** Changes in scope, reworks, contractual disputes, and project delays can lead to payment disruptions. These disruptions impede financial fluidity and complicate cash flow forecasting, often escalating into further disputes and extended project delays [85]. Establishing reliable payment schedules is crucial for maintaining financial health.

***Insufficient Expertise* (*CFF7*):** A lack of requisite skills and experience within project teams leads to inaccuracies in cost estimation and financial planning. This deficiency hampers decision-making and impedes the anticipation and mitigation of financial risks. Industry studies indicate that projects managed by inexperienced teams are more susceptible to budget overruns and delays due to ineffective handling of complex tasks and unforeseen challenges [5]. Enhancing team expertise is, therefore, imperative for accurate forecasting.

***Miscommunication* (*CFF8*):** Miscommunication among stakeholders generates errors and discrepancies between projected and actual expenditures. Implementing effective communication strategies—such as regular meetings and meticulous documentation—is essential to align stakeholders and ensure informed decision-making [28]. Clear communication channels directly contribute to the accuracy of cash flow forecasts.

***Insufficient Information* (*CFF9*):** A lack of comprehensive and current data presents a significant barrier to accurate cash flow forecasting. This problem often stems from inadequate data collection processes, poor information sharing, and reliance on outdated or incompatible information systems [78]. Investing in robust information management systems is critical to overcoming this challenge.

***Lack of Collaboration* (*CFF10*):** Fragmented efforts due to insufficient collaboration result in inconsistencies in cash flow forecasting. Promoting teamwork and utilizing collaborative tools enhance coordination, ensuring that all parties work synergistically towards common goals. This, in turn, improves project execution and financial reliability [81]. Fostering a collaborative culture is essential for effective financial management.

Collectively, these challenges underscore the multifaceted nature of cash flow forecasting difficulties in Saudi Arabian construction SMEs. The interdependency of these issues suggests that addressing them in isolation may be insufficient. For instance, improving technical expertise without enhancing communication and collaboration may yield limited benefits. Therefore, a holistic approach that integrates technological advancement, process optimization, and cultural shifts toward greater collaboration is imperative for overcoming these obstacles.

4.4. Role of BIM in Mitigating CFF Challenges

The literature on BIM applications has highlighted benefits that can help with CFF (refer to Table 4). With the purpose of re-evaluating those for construction SMEs in Saudi Arabia, it is imperative to discuss how each BIM-related benefit towards CFF can be achieved. Table 9 ranks these benefits based on WMR, highlighting their perceived effectiveness in enhancing financial management.

Table 9. Ranking of BIM benefits based on WMR.

Code	Benefits	WMR	Rank
BIM1	Enhances accuracy of cost information	4.43	1
BIM2	Improves data handling to improve information management	4.36	2
BIM3	Overall cost-savings	4.32	3
BIM4	Improves communication and collaboration	4.31	4
BIM5	Real-time updates to models for any changes	4.29	5
BIM6	Effective decision-making	4.29	6
BIM7	Improves cash flow monitoring	4.28	7
BIM8	Enhances risk mitigation	4.23	8
BIM9	Enhances resource allocation	4.22	9
BIM10	Enhances project administration of contract terms	4.19	10

Integrating temporal data into 3D BIM models—developed using software such as Revit (24.2.10.64) and SketchUp 2023—elevates them to 4D BIM, facilitating sophisticated simulation and optimization of construction processes [55]. This advancement employs specialized tools like Navisworks or Synchro Pro to link specific work units or elements within the 3D model to corresponding construction scheduling activities. Such detailed project scheduling is instrumental in generating accurate CFF.

Effective CFF is heavily dependent on precise cost information to generate accurate payment quantities. Advanced 5D BIM software—such as RIB CostX 7.1, and Vico Office (R6.6)—integrates cost data into 4D models, creating dynamic cost models that predict the contractor's expenses at any given stage of construction [55]. The application of BIM in construction projects confers numerous advantages, including clash detection, enhanced prefabrication processes, and improved communication and coordination among stakeholders [8]. These benefits collectively reduce variations and rework, thereby maintaining budgetary constraints. Notably, 5D BIM surpasses traditional methods by adeptly accommodating design changes, facilitating cost analysis, and identifying potential issues at early stages [8]. This approach not only enhances efficiency but also enables comprehensive construction visualization and precise cost estimation.

Moreover, BIM platforms such as BIM 360, Bentley ProjectWise, and Trimble Connect provide a Common Data Environment (CDE)—a centralized repository for all construction project information, encompassing documentation, graphical modelling data, contracts, schedules, and reports [56]. Compliance with standards like the Construction Operations

Building Information Exchange (COBie) and Industry Foundation Classes (IFC) ensures that the CDE maintains data integrity and security, mitigating risks of information loss [86]. Consequently, all CFF-related information can be accessed in real-time with appropriate authorization, significantly enhancing BIM's information management capabilities.

Additionally, BIM enables the encoding of contractual terms into data models, allowing for the extraction of payment terms and amounts based on construction progress and maintenance periods, thus streamlining timely payment administration without errors or complications [87,88]. It offers a digital alternative to mitigate ambiguities in contract payment terms and improve progress payment management. The integration of blockchain technology can further reinforce this system by enforcing payment terms and transparently sharing payment records. This synergy between blockchain, BIM, and smart contracts effectively addresses issues related to insolvency and delayed payments within the construction industry [89]. By ensuring prompt and secure transactions, this automated approach reduces the likelihood of financial difficulties and enhances overall payment management in building projects [12].

4.5. BIM Implementation Strategies

In response to the identified challenges hindering effective CFF within Saudi Arabian construction SMEs, particularly the underutilization of BIM, this study explores five strategic implementation approaches derived from an extensive literature review and corroborated by survey data (refer to Table 3). The strategies were assessed based on their WMR, and their rankings are detailed in Table 10.

Table 10. BIM implementation strategies WMR and ranking.

Code	BIM Application Strategy	WMR	Rank
STR1	Accessibility to affordable BIM training to enhance the workforce	4.58	1
STR2	Gradual implementation approach for smoother transition to a BIM integrated organisation	4.53	2
STR3	BIM workshops, seminars, and campaigns for clients, owners, and other project stakeholders	4.55	3
STR4	Government incentivises industry-wide adoption by providing regulations and policies	4.44	4
STR5	Collaborative partnerships among larger organisations, government entities, and SMEs for knowledge-sharing and mentoring	4.35	5

The highest-rated implementation strategy, according to the respondents, is STR1: Accessibility to affordable BIM training to enhance the workforce with a WMR of 4.58, highlighting the critical importance of workforce development in successful BIM adoption. Conversely, STR5: Collaborative partnerships among larger organizations, government entities, and SMEs for knowledge-sharing and mentoring received the lowest rating at 4.35, though it still reflects a strong consensus on its value.

These findings underscore the necessity for Saudi Arabian construction SMEs to prioritize internal capacity building while also engaging with external stakeholders to facilitate BIM integration. The emphasis on training and stakeholder engagement aligns with global best practices and can significantly impact the effectiveness of CFF.

Detailed Analysis and Discussion of Implementation Strategies

STR1: Accessibility to Affordable BIM Training to Enhance the Workforce

Investing in employee training is paramount for SMEs aiming to leverage BIM effectively in CFF. As per [55], SMEs can collaborate with educational institutions, industry associations, or specialized training providers to offer customized BIM training programs. These programs should focus on practical applications of BIM in financial management, including modules on 5D BIM for cost estimation and cash flow analysis.

A Saudi Arabian SME, *Al-Futtaim Construction*, partnered with *Prince Sultan University* to deliver a tailored BIM training program for its finance and project management teams. The program included hands-on workshops on using BIM software (i.e., RIB CostX 7.1) for cash flow forecasting and cost control. Post-training, the company reported a 20% improvement in the accuracy of its cash flow projections and a reduction in project cost overruns. The flexibility of training schedules and the availability of certifications upon completion motivate employees to engage actively in skill development. This approach addresses the skills gap and empowers the workforce to utilize BIM tools effectively for enhanced CFF.

STR3: BIM Workshops, Seminars, and Campaigns for Clients, Owners, and Other Project Stakeholders

Engaging key stakeholders through educational initiatives can significantly reduce resistance to BIM adoption. Stakeholders often harbour misconceptions that BIM implementation may disrupt existing workflows or complicate project management processes [90]. Organizing workshops and seminars raises awareness about the tangible benefits of BIM in improving financial transparency, cost control, and collaborative efficiency.

In Malaysia, the *Construction Industry Development Board* (*CIDB*) conducted nationwide BIM seminars targeting SMEs, which led to a marked increase in BIM adoption rates [22,49]. Similarly, Saudi SMEs can replicate this strategy by hosting events that demonstrate BIM's role in optimizing CFF, thus fostering a collaborative environment that supports technological advancement. By educating clients and partners, SMEs can facilitate smoother project execution, as all parties understand and appreciate the value BIM brings to financial management and project delivery.

STR2: Gradual Implementation Approach for Smoother Transition to a BIM-Integrated Organisation

Adopting BIM incrementally allows SMEs to manage the transition without overwhelming their resources or disrupting ongoing projects. BIM Level 3 maturity represents full integration, including collaborative working and integrated project delivery, which can be daunting for SMEs with limited experience.

A construction organization in the UK, adopted a phased BIM implementation strategy. Initially, they focused on 3D modeling to improve design visualization. Subsequently, they integrated 4D scheduling and 5D cost estimation, directly enhancing their CFF processes [55]. This gradual approach enabled the company to adjust to new workflows and realize immediate benefits without significant upfront investment. Conducting a comprehensive assessment of the organisation's current BIM capabilities, resources, and processes allows SMEs to identify priority areas for development. Over time, this strategy ensures a smoother transition to a fully BIM-integrated organisation, directly impacting the accuracy and efficiency of cash flow forecasting.

STR4: Government Incentivises Industry-Wide Adoption by Providing Regulations and Policies

Government support can accelerate BIM adoption by reducing financial barriers and establishing industry standards. Regulations that mandate BIM usage for public projects, along with incentives such as subsidies or tax relief for investment in BIM technology, can encourage SMEs to adopt BIM.

In China, the government's directive to adopt BIM for all public construction projects led to widespread BIM implementation among SMEs [39,91]. The provision of financial incentives and clear regulatory frameworks reduced the cost burden and uncertainty associated with adopting new technologies. For Saudi Arabia, integrating BIM mandates into the *Vision 2030* initiative could promote industry-wide adoption. This governmental push would not only standardize BIM practices but also enhance SMEs' capabilities in CFF by providing access to advanced tools and methodologies.

STR5: Collaborative Partnerships Among Larger Organisations, Government Entities, and SMEs for Knowledge-Sharing and Mentoring

Forming strategic partnerships can provide SMEs with access to resources, expertise, and technologies that might otherwise be unattainable. Knowledge-sharing initiatives, mentorship programs, and joint ventures facilitate the transfer of best practices in BIM and CFF.

In New Zealand, the *BIM Acceleration Committee* facilitated collaborations between large construction firms and SMEs, focusing on mentoring and resource sharing [92]. These partnerships enabled SMEs to adopt BIM more effectively, resulting in improved project delivery and financial performance. Saudi SMEs can engage with multinational corporations (MNCs) and government agencies to participate in pilot projects or joint training programs. Such collaborations can enhance their understanding of BIM's application in CFF and expedite the adoption process. Depending on their suitability, these BIM implementation strategies can help construction SMEs in Saudi Arabia augment their workforce capabilities and ensure smoother CFF and other activities.

5. Integrating BIM into CFF: A Proposed Guideline

Implementing BIM within the CFF processes of Saudi Arabian construction SMEs requires a strategic approach that addresses both technical and human factors. By prioritizing workforce development, engaging stakeholders, adopting BIM incrementally, leveraging government support, and forming collaborative partnerships, SMEs can overcome barriers to adoption.

Building on the analysis, this study proposes a guideline (refer to Figure 7) to facilitate Saudi Arabian construction SMEs to integrate BIM into their CFF processes effectively. This guideline synthesizes the implementation strategies and highlights the specific application and role of BIM in enhancing cash flow forecasting.

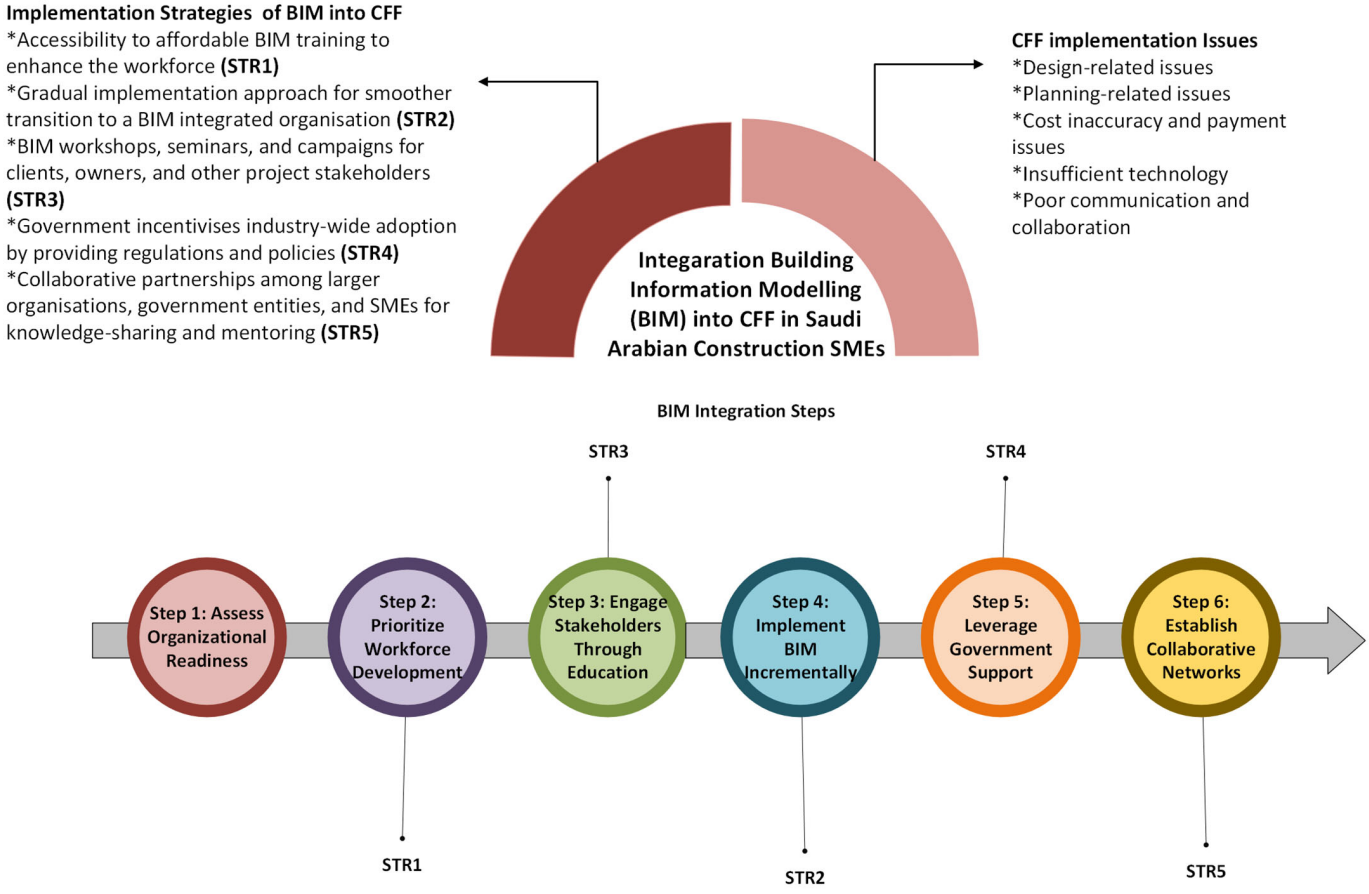

Figure 7. A theoretical guideline on integrating BIM in CFF.

Step 1: Assess Organisational Readiness

Evaluate current BIM capabilities and financial management processes, and identify gaps in skills, technology, and workflows. This assessment informs the development of a tailored implementation plan.

Step 2: Prioritise Workforce Development (STR1)

Invest in affordable and accessible BIM training programs focused on CFF applications. Training should cover:

- Use of 5D BIM for cost estimation and cash flow analysis.
- Integration of BIM software with financial management systems.
- Case studies demonstrating successful BIM implementation in CFF.

Step 3: Engage Stakeholders through Education (STR3)

Organize workshops and seminars for clients, owners, and project managers to:

- Demonstrate the benefits of BIM in financial transparency and efficiency.
- Address misconceptions and reduce resistance to change.
- Encourage collaborative adoption of BIM practices.

Step 4: Implement BIM Incrementally (STR2)

Adopt a phased approach to BIM integration:

- Phase 1: Implement 3D modeling for design accuracy.
- Phase 2: Integrate 4D scheduling to improve project timelines.
- Phase 3: Utilise 5D BIM for detailed cost estimation and cash flow forecasting.

Step 5: Leverage Government Support (STR4)

Take advantage of governmental policies and incentives:

- Apply for subsidies or grants aimed at technology adoption.
- Aligning projects with government initiatives that require or favor BIM usage.
- Participate in government-sponsored training programs.

Step 6: Establish Collaborative Networks (STR5)

Form partnerships with larger organisations and industry bodies:

- Engage in mentorship programs to learn from experienced BIM users.
- Share resources and best practices within a network of SMEs.
- Collaborate on projects to gain practical experience in BIM applications.

This gradual implementation suggested in this guideline envisions to minimise disruption and allows for adjustments based on feedback and performance.

6. Conclusions and Way Forward

This study has critically examined the pivotal role of BIM in enhancing CFF among construction SMEs in Saudi Arabia. Recognizing that these SMEs occupy a crucial position within the Saudi construction landscape—undertaking numerous projects constrained by stringent budgets and tight timeframes in a highly competitive market—it becomes imperative that their CFM is both robust and efficacious. Accurate CFF emerges as an indispensable technique within CFM, bolstering financial performance by precisely predicting cash influx and outflow points throughout a project's timeline, thus ensuring efficient resource allocation and underpinning the financial sustainability of the enterprise.

Traditionally, CFF is conducted through static mathematical models and algorithms, which often lack the dynamic adaptability required for complex construction projects. However, there is a discernible shift towards the integration of BIM-enabled models, which offer superior accuracy and facilitate sustainable financial planning within organizations. BIM's multidimensional capabilities allow for the integration of time (4D), cost (5D), and resource data, providing a more holistic and real-time view of project finances [55]. Despite

these advantages, specific segments of the industry—notably Saudi Arabian construction SMEs—encounter manifold difficulties in integrating BIM for CFF purposes.

Our research has illuminated the challenges these SMEs face in CFF and delineated how BIM can serve as a comprehensive solution. Accordingly, the study identified 'Inaccurate Estimates', 'Scope Changes', and 'Project Delays' as the most critical challenges impeding effective CFF. These impediments are intrinsically linked to managerial and organizational inefficiencies, which significantly compromise CFF and, by extension, financial stability and sustainability.

Integrating BIM addresses these challenges by enhancing the accuracy of cost information through detailed quantity take-offs and cost estimation modules, which directly mitigate issues related to inaccurate estimates. However, the adoption of BIM among SMEs remains limited, hampered by barriers such as exorbitant costs, a dearth of awareness, and inadequate implementation strategies. To surmount these obstacles, the study proposes strategic interventions including:

1. Accessible BIM Training: Providing affordable and flexible training programs tailored to the needs of SMEs enhances workforce competencies and facilitates smoother adoption.
2. Phased Implementation Approach: Gradually integrating BIM into organizational processes reduces disruption and allows SMEs to build capacity over time, starting with essential functions like cost estimation and progressively adding more complex features.
3. Targeted Stakeholder Education: Conducting workshops and seminars for clients, owners, and other stakeholders fosters a collaborative environment and aligns expectations, mitigating resistance and enhancing cooperation.

These measures are poised to propel both financial and sustainable development within the industry by equipping SMEs with the tools and knowledge necessary to leverage BIM effectively.

From a practical implication viewpoint, this study extends valuable insights for construction SMEs in Saudi Arabia seeking to enhance their CFF through BIM integration. By adopting the recommended strategies, these SMEs can refine their financial management practices, thereby augmenting their competitiveness and elevating project success rates. Such innovative steps are instrumental in contributing to the broader objective of sustainable economic growth, in alignment with the nation's Vision 2030.

Looking ahead, future research might explore the integration of BIM in other countries, confronting similar challenges, potentially prompting governmental mandates for BIM adoption. Comparative studies could provide deeper insights into the best practices and inform policy development. Moreover, the intersection of BIM with emerging technologies such as Artificial Intelligence (AI) and blockchain holds considerable promise for further augmenting the accuracy, efficiency, and sustainability of CFF. AI algorithms can enhance predictive analytics within BIM models, improving forecast accuracy and risk assessment. Blockchain technology can secure data integrity and transparency in financial transactions, addressing issues related to payment disruptions and contractual disputes. By embracing these advancements, SMEs can reinforce their financial capabilities, ensure enduring project success, and contribute significantly to the evolution of a more sustainable construction industry.

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