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An Investigation of BIM Advantages in Analysing Claims Procedures Related to the Extension of Time and Money in the KSA Construction Industry

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Abstract: The construction industry in the Kingdom of Saudi Arabia (KSA) is a significant sector in the Middle East, with annual expenditures exceeding USD 120 billion. It employs 15% of the workforce and consumes more than 14% of the country's energy resources. Despite the significant growth in the Saudi construction sector, it faces various challenges due to the rapid launch of mega projects, such as the Line project engaged with the NEOM project, as well as other new projects as part of the Saudi Vision 2030. The challenges might be limited to a shortage of skilled labourers, rising costs, construction disputes, and material shortages. This study aims to investigate claims management procedures under traditional practice and compare them with a proposed BIM package as an alternative solution to mitigate construction disputes. The objective of the study focuses on reducing the time consumed when analysing claims against the level of accuracy of claims values. The proposed BIM model improves and streamlines the claims process through automation. This study presents prospective and retrospective methods in delay analysis under an accepted programme. A questionnaire survey was conducted, and out of a total of 123 practitioners, 79 replied. The findings in tables in this article reveal that there are demands and a growing awareness of BIM in the KSA construction industry. The results reveal that BIM can help to reduce potential disputes and can reduce overall project cost overruns.

Keywords: building information modelling; Kingdom of Saudi Arabia; disputes; construction; contracts; procurement

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1. Introduction

The triangle of time, cost, and quality were the key indicators used to measure project success; however, over time, other indicators have been added, such as safety, lean and green building, and dispute-free processes [1,2]. Contracting parties might change their contractual and economic relationships through claims. Research shows that project managers spend 25% of their time resolving conflicts [3]. According to Arcadis (2019) [4], global construction disputes take around 17 months to resolve, with an average cost of USD 33 million for these disputes. Indirect expenses include project quality loss and undesirable working relationships between parties who could benefit from long-term collaboration. It is stated that delays might add from 3–10% to 70% in terms of additional time for construction projects [5]. This emphasises the significance of proper claims management practices and procedures [6]. Managing claims in construction projects remains a time-consuming and difficult undertaking [7]. In addition, inefficiencies might be found in the current traditional methods of claims management. Therefore, there is a high demand for data storage and processing because the construction process is extensive and takes considerably long. However, it has been noted that data collection, analysis, and presentation are significant obstacles to how claims are managed. Under the traditional methods of claims management, collecting all necessary data and paperwork is an essential process for preparing, presenting, analysing, and handling the claims [8]. Claims must be supported by evidence, including all required information, adhere to procedures, and be submitted within a certain time frame [9]. The complexity of claims management in the Kingdom of Saudi Arabia (KSA) is increased by the absence of an effective document management system and qualified people to oversee the entire procedure of claims, particularly those with the best understanding of claims. Consequently, the current dispute and claim resolution processes in the KSA are still lengthy and complicated [10].

The problem is that traditional practices in construction management necessitate the implementation of new methods for claim procedures [11]. Without an efficient claims management system, claimant parties face the risk of losses. For instance, when a project owner requests a change order to change the air conditioning system from duct split to package units during the construction process, the package units will require duct routes that may intersect concrete beams or increase the false ceiling depth, affecting the clear height of the room. Therefore, to prevent potential money and time claims in later stages, a rapid and accurate revision is required to evaluate the technical design impact, providing a detailed price and time impact for the new item. Hence, it is crucial to employ advanced methods that are interactive, proactive, and capable for handling large volumes of construction information while dynamically engaging with the available data. It is crucial to realise that Information and Communication Technologies (ICTs) have undergone substantial advancements in the past few decades and can be employed to enhance the existing management methods [9].

The rapid and innovative progress in ICTs has had a significant influence on the Architectural, Engineering, and Construction (AEC) sector, as well as its administration and sharing of information [12]. The connection between technology, construction, and legislation is characterised by a dynamic and reciprocal interaction, where modifications in one domain consistently exert an impact on the others. Research has demonstrated that specific computing and ICT tools are approaching their maximum capabilities as researchers and practitioners work towards resolving intricate problems. Quantum computing (QC) is a swiftly progressing technology with the capacity to fundamentally transform computational capabilities across multiple domains, including engineering. It facilitates intricate calculations that are now unreachable or excessively time-consuming [13]. The quantum computing market is forecasted to have a significant 500% expansion over 7 years. Nevertheless, there has been a lack of focus on this technology and its prospective applications in the (AEC) industry, which has faced criticism for its sluggish implementation of ICT tools [13].

Building information modelling (BIM) is a technology that offers significant benefits in construction management for diverse projects. The main components of employing BIM are its technological capabilities, interoperability, early dispute detection, integrated procurement, enhanced cost management methods, reduced team conflict, and project team benefits [14]. Although BIM is not a new concept, it has gained considerable attention in recent years, particularly in UK construction projects [14]. Policy measures, such as the UK Government's Construction 2025 vision, promote the adoption of the BIM method in order to achieve lower construction costs and faster project delivery. Similarly, countries such as Finland, Denmark, and the United States require AEC firms to implement BIM when undertaking public construction projects [15].

The construction sector in the Kingdom of Saudi Arabia (KSA) is planned to be widely expanded with extensive renovation in the existing infrastructure. Precisely, the KSA is dedicated to accomplishing the developmental objectives delineated in "Vision 2030", which is supported by a substantial 2018 budget of USD 260.8 billion, the largest in the history of the KSA [16]. For example, the first phase of the NEOM project is planned to be opened in 2030 with an estimated budget of USD 5 billion. Hence, the present is an opportune time for the KSA to align with the sustainable development trend observed in countries such as the United States, the United Kingdom, and Australia by embracing

BIM [17]. Despite a limited amount of documented work, a comprehensive literature review indicates that the KSA has not yet fully harnessed the potential advantages of BIM. Extensive research on BIM acceptance and implementation in the Saudi construction industry demonstrates many study areas, gaps, benefits, and barriers [18]. Consequently, this paper outlines these aspects, providing a solid foundation for future BIM research within the KSA. The automation of claims management processes in the KSA construction industry has been the subject of limited publications, with scarce availability of claims management based on BIM models, as indicated by survey findings [1]. This study aims to present a claims management model by utilising BIM to promote a systematic approach for efficient and streamlined claims processing and more effective claims management practices. In addition, the purpose of the presented theoretical model is to enhance the accuracy of claims values in a short time to reduce the prolongation of claim.

The proposed model was based on time analysis and cost estimation software. It aimed to analyse time-related claims using either Microsoft Project or Primavera. The cost estimation utilised (Cost-X) as part of the BIM package [9]. Hence, the BIM package aimed to provide a more precise estimation of claimed time or cost, a realistic assessment of risks of potential conflicts, and timely resolution of errors and omissions. To establish a BIM-based claims management model, the researchers selected claims that the model could represent in terms of affected building elements [19,20]. The most prevalent construction claims were identified through a questionnaire focusing on the extensions of time and money claims for inclusion in the BIM-based claim management model [15].

The proposed theoretical model also aims to enhance the practice in the construction field, particularly in the KSA construction industry. The rationale behind the proposed model in this study lies in the performance indicators utilised during claim assessments. These indicators include factors such as time efficiency in claim submission, the accuracy and completeness of documentation, adherence to legal and regulatory requirements, contractual obligations, and the cost and effectiveness of the resolution process. Certainly, when comparing BIM-based claims assessment to traditional practices in construction, we can formulate sets of hypotheses to guide this research. Therefore, four hypotheses are proposed and listed in Table 1 to establish clear objectives for this study and support the proposed framework for testing the effectiveness of BIM in claims management from the field survey perspective as well.

Table 1. Hypotheses that guide the research objectives.

Hypothesis	Null Hypothesis (H0)	Alternative Hypothesis (H1)
H1: BIM improves the accuracy and completeness of documentation.	There is no difference in the accuracy and completeness of documentation between BIM-based claims assessment and traditional practices.	BIM-based claims assessment leads to more accurate and complete documentation compared to traditional practices.
H2: BIM improves time efficiency in claims processing.	The time efficacy of claims processing does not differ significantly between BIM-based assessment and conventional practices.	BIM-based claims assessment yields a processing timeline that is both expedited and more effective in comparison to traditional methodologies.
H3: BIM reduces dispute resolution time.	The time required to resolve disputes is not different between BIM-based and traditional practices.	BIM-based claims assessment expedites the resolution of disputes compared to traditional methods.
H4: The communication in claims management is enhanced by BIM.	The communication effectiveness of BIM-based claims assessment is not significantly different from that of conventional practices.	Compared to conventional practices, BIM-based claims assessment increases the effectiveness of communication among the parties involved in the claims process.

2. Literature Review

2.1. A Review of Claims Management Procedures

The steps of a claim procedure are identification, notification, documentation, presentation, analysis through examination, negotiation, and settlement, and all these processes require different resources to be engaged and co-ordinated [5,19]. Identifying a claim in the construction industry requires the prompt and precise recognition of an alteration. It is the first and most significant step in alerting the engineer to the formation of a potential problem. The time constraint is also significant, and the engineer and the company have their respective responsibilities outlined in the contract at this point [21]. Claims documentation is also crucial to the claims settlement process [20]. Therefore, it is imperative that all the necessary documentation, such as drawings, specifications, written instructions, and timetables, be gathered in one place [22]. The engineer is provided with these records for review and evaluates and decides the amount of compensation after receiving a formal claim [21]. Negotiation is the last step in the claims management process, which is the settlement of the claim. The parties offer an alternate dispute settlement process if they cannot agree and each believes they are in the right [21]. Similar previous studies in the field of construction management proposed solutions to aid the claims procedures and analyses, such as an expert system framework for evaluating claims. In addition, a hypertext-based claims analysis system and a simulation-based approach were proposed for making claims decisions [5,23]. Moreover, decision support systems for delay analysis that encompass an information system for managing delays and an agent-based collaborative system for resolving claims were suggested. An automated system called Claims Manager 2000 is used for administering construction claims as a process model [24,25]. Many of these studies aimed to utilise the visual parameters of building models to connect them to a central database containing information pertaining to claims for each respective model component. Potentially, the database may be used to see the stated parts of a project in context and see how they work together [26]. If this was possible, it may aid in the formulation and evaluation of claims by allowing for a fast access to and retrieval of the relevant information related to each model component [9]. Finally, one of the claims procedures and analyses is the traditional approach, as detailed in the following section.

2.2. Claims Management Analysis under the Traditional Approach

The procedures concerning construction claims under traditional approaches encompass a well-organised sequence of steps and processes that are adhered to by the parties engaged in a construction project in the event of a dispute or claim [25]. These procedures are typically delineated in the construction contract and may be subject to variation depending on the specific terms and conditions stipulated in the signed contract. In this research, Figure 1 outlines the customary steps in construction claims procedures under traditional approaches [16,18]. Initiating a claim requires the entitled party, typically the contractor or subcontractor, to submit a written notice to the other involved party, usually the owner or general contractor. The notice of a claim should be based on the established claim procedure, including the determination of causation and the right to claim, accompanied by the relevant supporting documentation serving as a burden of proof, as indicated in Figure 1. However, the authors believe that the most crucial stage is the formulation of the claim, which necessitates contractual and legal substantiation through the provision of supporting documentation. The duration of the claim formulation and submission is not limited to when a bespoke contract is used under the traditional approach unless agreed otherwise. The preparation of a claim should rely upon appropriate tools and resources to be expedited [9]. Conversely, in the case of using the FIDIC standard contract form, a party entitled to make a claim must submit the claim as soon as practicable and no later than 28 days from the occurrence of the action related to the claim, such as a change in scope or variations, as indicated in Figure 1. Failure to comply with the time frame will result in the forfeit of the entitled party's right to raise a claim later. Therefore, depending solely on the conventional approaches for analysing claims may not grant the claimant the prerogative to scrutinise and submit the claim thoroughly [22]. This is one of the rationales behind this research endeavour, which aims to investigate the utilisation of BIM to evaluate and submit claims, ensuring a more efficient, less timely, and seamless process.

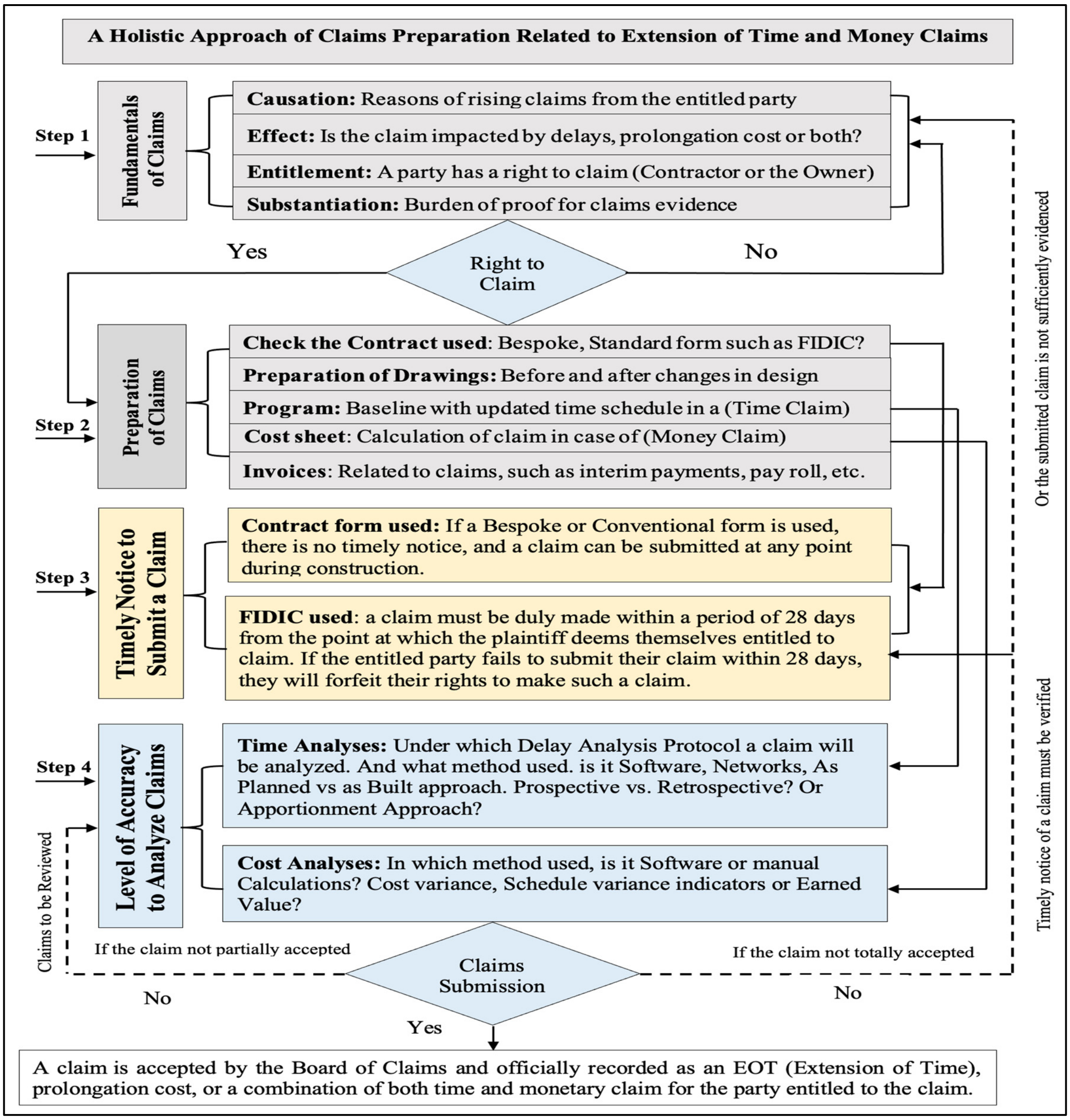

Figure 1. Flow chart created by the authors to show claims procedures and analyses under a traditional approach.

Unlike the FIDIC contract conditions, the doctrine and Sharia law applicable in the KSA allows for certain rights to be exempt from a statute of limitations. This means the claimant can submit a claim at any time during the project, even after completion, within a reasonable time frame [22]. The statutory limitations that result in the forfeiture of rights when raising a claim after a definite time and interest charge due to delayed payments under FIDIC conditions serve as significant obstacles to the full applicability of the FIDIC in the KSA industry due to its conflict with Sharia law. In certain instances, the contracting parties within the KSA industry may customise their contract conditions by selecting specific articles from the FIDIC conditions and referring to the agreement as a mini-FIDIC. Such adaptations may enhance contractual autonomy and align with Sharia law regulations. As indicated in Figure 1, the level of accuracy required to analyse the construction claim under a traditional approach necessitates a comprehensive undertaking, encompassing an analysis of the delays and costs. The claimant must select the appropriate protocol for analysing the delay and the relevant indicators for cost analysis as the burden of proof lies with the party seeking to convince the court or arbitration tribunal.

Most importantly, managing the FIDIC contract can be challenging. For instance, if the contractor spends a long time preparing and analysing a claim, they may lose the right to claim within the 28-day period specified by the FIDIC. Therefore, utilising BIM applications alongside the FIDIC promotes a better collaboration and communication among project stakeholders, aligning with the collaborative principles emphasised in FIDIC contracts. In some instances, the process of handling claims can be complex and time-consuming, as it involves verifying that the constructed elements adhere to the specified requirements outlined in FIDIC contracts. Therefore, BIM provides accurate documentation and effective change tracking, which contribute to claims management by providing a strong foundation for resolving disputes related to delays, variations, or other contractual matters.

2.3. Analysing the Extension of Time with Money Claims under the Traditional Approach

Extension of time (EOT) and delay analysis are inherent in any construction project, especially regarding money claims. Figure 2 presents an overview of the classifications and types of delays and their corresponding impacts on the accountable party for the delays and the nature of compensation [26]. Delays in construction projects can result in additional costs, prompting the parties involved to seek compensation or time extensions to mitigate these effects. Typically, there is a connection between an EOT and delay analysis regarding money claims. An EOT refers to a formal request initiated by a contractor, which might prolong the completion date of a project beyond the initially agreed-upon contract duration [26]. This extension is typically granted in cases where delays occur due to circumstances beyond the contractor's control, such as adverse weather conditions, unforeseen site conditions, or modifications in the project scope. It is worth noting that, when an EOT is granted, considerable financial implications are involved, particularly in avoiding liquidated damages. In many construction contracts, liquidated damages are stipulated as monetary penalties imposed on the contractor for project completion delays. However, by obtaining an EOT, the contractor can potentially mitigate or altogether avoid these penalties [20]. Moreover, an EOT may have financial implications as contractors may incur additional costs during the extended period, including expenses related to labour, equipment, and site overheads. Consequently, these additional costs can be included in the contractor's monetary claims [27].

Concurrent delays in construction projects refer to multiple delays that occur simultaneously, are caused by multiple parties, and might impact the progress of a construction project. Figure 2 refers to the types of delays, including concurrent and nonconcurrent delays, in which nonconcurrent delays are serial independent delays [28]. In addition, Figure 3 illustrates concurrent delays in terms of concurrency and effects, in which true concurrent delays are simultaneous events from both the owner and the contractor, while concurrent effects are non-simultaneous events that occur at different times. In Figure 3a, two concurrent delay events occur on the same day (day 4), one caused by the owner and the other by the contractor. Both events are on parallel critical paths, resulting in simultaneous project delays on day 9. Thus, the delays are concurrent in this case. Figure 3b demonstrates a variation where the contractor event occurs on day 4, while the owner event is scheduled for day 6 [28]. Both events remain highly significant, leading to a project delay that becomes apparent on day 9. As the events causing the delay do not transpire simultaneously, this circumstance can be classified as concurrent effects, with the contractor being solely accountable for the resulting uncertainty. However, from a safety perspective, the increased safety risks in construction activities occur when two or more activities on a construction site take place simultaneously within a shared timeframe, referred to as concurrency [29]. When there is a lack of using BIM, project management tools, such as

Microsoft Project, are often utilised to schedule and organise project activities, enabling the identification of overlaps between activities [29].

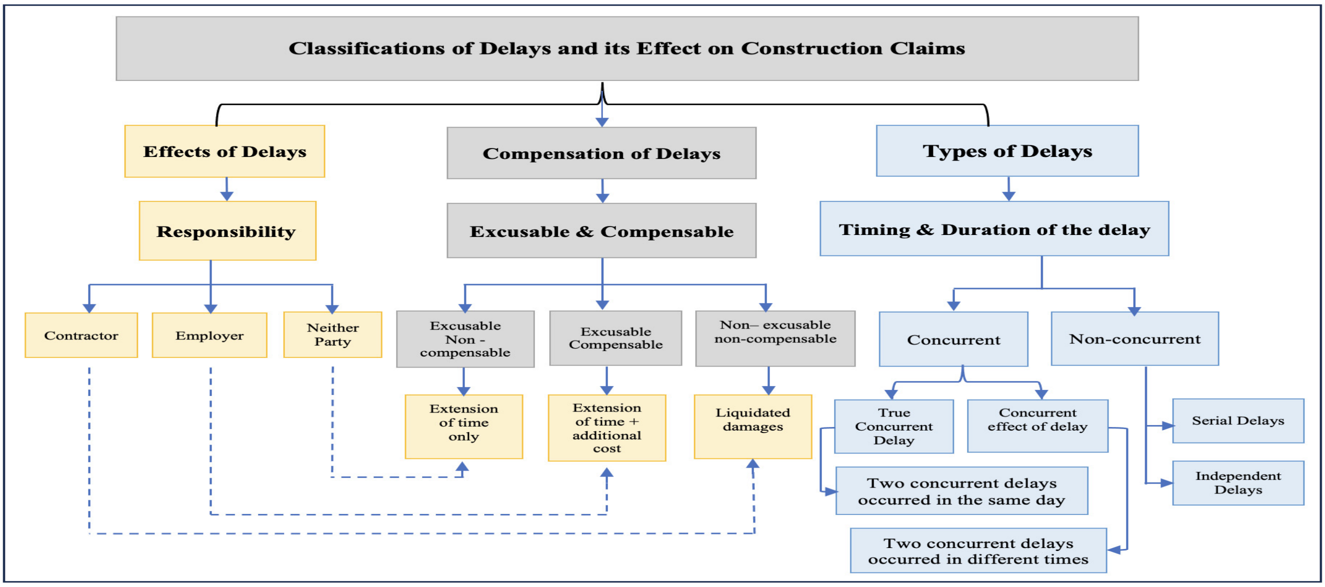

Figure 2. Types and classification of delays with their effects on the involved parties in construction projects.

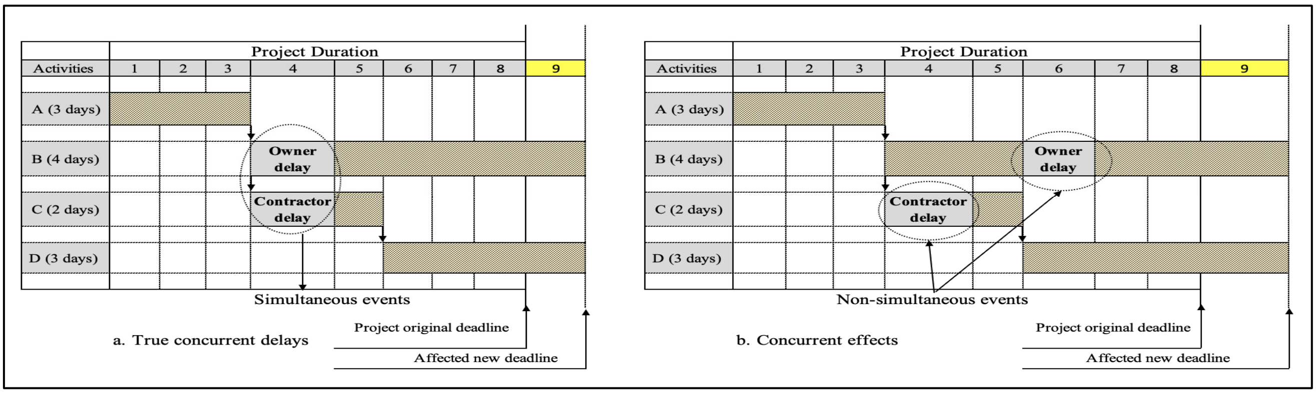

Figure 3. True concurrent delay events vs. concurrent effects, adopted from [28].

Analysing delays under the traditional approach is a difficult task, especially concurrent delays, which can be a significant challenge and may lead to conflicts and claims between the involved parties in the project. Effectively addressing concurrent delays necessitates a wide knowledge of contractual terms, effective communication, and a proactive approach towards mitigation and resolution. It can be challenging to ascertain the occurrence of concurrent delays, as they frequently involve a combination of excusable and non-excusable delays. Most construction contracts do not encompass methods and procedures for delay analysis, which are essential in determining the causes and responsibilities of delays [29]. The absence of a defined protocol or methodology for analysing delays in traditional approaches in countries such as the KSA, Egypt, or the United Arab Emirates, particularly during a claim event, may pose difficulties for the contracting parties. However, in the UK construction industry, the "Delays and Disruption Protocol" established by the Society of Construction Law (SCL) says that, in cases where both the employer and contractor contribute to concurrent delays in the project, this results in additional costs for the contractor [29]. Therefore, the contractor is entitled to receive reimbursement solely on the condition of effectively distinguishing the additional costs resulting from the employer's delay from those arising from the contractor's delay. If the contractor is responsible for the delay that resulted in additional costs, the contractor will not be eligible to claim reimbursement for those additional costs.

2.4. BIM Package as an Alternative Approach to Resolve Disputes in Construction Projects

The widespread adoption of BIM allows for a more integrated design and construction process, resulting in improved quality and reduced costs and time in construction projects [1,27]. Despite the potential hurdles, such as model ownership issues, copyright protection concerns, ambiguity over design liability, a lack of contractual rules, and concerns about model security and privacy, there is evidence that BIM provides advantages to the industry. Government entities and experts in the construction sector are drawn to BIM as a solution to the challenges faced by the construction industry, owing to its numerous benefits [30]. Various BIM systems, such as BIM-Storm, aid in creating a design that aligns with the owner's financial constraints and unique requirements [16]. BIM-Storm facilitates online collaboration among participants to assess design alternatives from the perspectives of cost, time, and sustainability to establish more accurate programme requirements. BIM is a tool for identifying design flaws and evaluating modifications to a model. It can automatically generate a report detailing the changes made to 3D objects between different versions of the model. BIM is mostly associated with enhancing document management and control [31]. When prior experiences are thoroughly documented, they can be utilised to accurately anticipate future conflicts and difficulties [32].

BIM enables comparisons between a project's as-planned vs. as-built data approach, allowing it to provide warnings about cost, time, and quality discrepancies [33]. Therefore, it can analyse and manage time, resources, costs, and conflicts, involving timely decision-making. The use of BIM in quality management is also reasonable [34]. It identifies quality disputes by identifying the quality control criteria and responsibility assignments in the construction process through inspection and testing, as well as providing analysis during the construction phase and feedback on inspection results [35]. As one of the leading causes of project schedule and budget overruns, construction defects can be identified through BIM-assisted automated inspection by utilising augmented reality and image-matching technologies [14,36]. An inadequate safety performance may be improved with the use of BIM, which uses safety rule checking and automatic safety rule simulation to help to make construction sites safer and healthier for workers [9,33]. BIM can help construction managers or owners to analyse and manage process conflicts and safety issues by dynamically supporting the safety analysis of structures and the clash detection of site facilities [37]. Scheduling and space conflicts may be easily analysed with the use of BIM. The mandated collaborative sessions in BIM have been demonstrated to boost trust and communication between the parties involved [38]. By its very nature, BIM will lead to a better communication among all parties involved. Claims can be reduced by using a BIM-based, integrated, and trustworthy approach. One of the most obvious benefits of investing in BIM is enhanced collaboration and communication among the team members [39].

When it comes to common data sharing, the BIM method is a built item that aids in design, construction, and operation and is a future information communication technology (ICT) resource for responsible decision making [5]. It supports interdisciplinary co-operation, knowledge sharing, management changes, and information support throughout the facility lifecycle, as well as drawing and documentation [40]. Information models can incorporate contracts, specifications, properties, employees, programming, numbers, costs, places, and geometry. BIM makes 3D presentations, stores data digitally, and quickly updates and shares data. For example, BIM enables the creation of detailed and accurate 3D models, providing a comprehensive visual representation of the construction project when a claim is related to a change in the original scope. Accurate documentation through BIM helps the parties involved in a dispute to reference the original design intent, construction sequences, and changes over time. BIM allows for the efficient tracking of changes throughout the project lifecycle. Visualisation features in BIM make it easier for stakeholders to identify and understand design changes, construction variations, and as-built conditions, effectively addressing claims related to changes.

BIM can be used for accurate quantity take-offs and measurements, reducing disputes related to discrepancies in quantities. The ability to extract precise data from the BIM model assists in quantifying work performed and evaluating variations from the original scope. From a contractual perspective, BIM helps to ensure compliance with the legal and regulatory requirements by providing a transparent record of design, construction, and changes. This transparency assists in addressing claims related to non-compliance with contractual or regulatory obligations. BIM helps stakeholders to communicate and collaborate on shared project models, as well as access, co-ordinate, and share data [5,41]. Project management, construction, engineering, IT, policy, and regulations use BIM knowledge [42]. BIM has transformed the traditional construction industry from a linear and fragmented industry to one in which project stakeholders share common objectives [5,38,43].

2.5. The Adaptation of BIM in Claims Management

BIM has played a crucial role in the evolution of multiple construction management disciplines, including construction claims management [18]. The outcome of a claim is heavily dependent on the quality of the claim report [44,45]. However, claim evidence in the KSA construction industry is still presented in person, through handwritten documentation, which can be presented via computer-generated digital data, in the case of BIM use [44]. Utilising electronic, visual, and demonstrative evidence for construction claims will likely accelerate the construction industry's adoption of BIM [44]. All project information would be stored in a central database linked to a 3D model that could be used to aid in the identification, quantification, and visualisation of claims if BIM is implemented in a project from its inception and the recommended record-keeping procedures are followed [44]. Visualisation is essential for obtaining the desired outcomes because, in many claim cases, the work related to a claim case might be invisible on site and covered by other activities, requiring it to be better visualised, especially when the raised claim is late in the construction process [46]. It is predominantly used to enhance communication in architectural design, but its benefits can be observed throughout the entire project lifecycle [5]. Consequently, BIM can be adopted as an essential resource for proactively resolving conflicts and claims to avoid disputes [47].

2.6. Associated Risks with BIM Application

The connection between technological advances, the construction industry, and legal aspects is characterised by constant evolution, wherein advancements in one domain invariably influence others; BIM is a significant advancement in this regard [48,49]. The utilisation of BIM technology in the construction industry is subject to various factors and limitations. However, the associated risks with BIM employment have surfaced as a challenge rather than a solution in some projects. This is attributed to inadequate comprehension by the parties responsible for the liability and accountability of the BIM method during the design, construction, and maintenance stages [50]. The contrasting features of BIM's collaborative nature, which facilitates a platform for sharing among those involved in the project, and the contractual nature, which tends to isolate and insulate rather than support and collaborate, have been identified as a complex difference [48].

In order to mitigate the associated risks, the parties involved in a construction project using the BIM process must sign a single legal agreement laying out their respective technical and legal responsibilities throughout the modelling phase [38,48]. Inexperience with BIM technology in a contractually based model leads to issues with the enforceability of specific regulations and agreements for BIM integration within construction projects [51]. Since the construction industry's efforts to reach a level 3 BIM by 2016, wherein all parties work together on a single model, this challenge has arisen [52]. Due to BIM's contractual and legal risks and the immaturity of BIM practices, adopting BIM as a working methodology is fraught with risk and uncertainty from the aforementioned angles. In addition, BIM relies heavily on software and hardware systems that can be prone to failure or malfunction, which might lead to delays in construction schedules and additional costs [51].

Associated risks might be extended to the lifecycle of the project after the construction stage and during the operation phase, when there is a lack of implementation of a building management system based on BIM. Research in the Iranian construction industry focused on the importance of examining risks and their interconnections for the effective implementation of Energy Performance Contracting (EPC) projects in developing countries with significant energy usage [53]. The use of hybrid method techniques has generated a valuable network relation map, providing insights into the interconnections among various risk dimensions and determinants. The project lifecycle risks are closely linked to other risks, either causally or consequentially [53]. This highlights the need for efficient risk management solutions, specifically for hazards and risks throughout the project lifecycle.

3. A Proposed Theoretical Framework Based on the BIM Package for Claims Analyses

The research authors designed the theoretical framework shown in Figure 4 as an alternative approach for analysing claims based on the BIM package instead of the traditional practice. In the realm of traditional practice, the potential resilience of technological advancements may be restricted, or software could be employed in isolation rather than in an integrated manner. In the realm of construction claims analysis using the BIM package shown in the Figure 4, both prospective and retrospective methods can be practically employed. The theoretical framework is divided into three stages, in which stage one identifies both the contractor and owner responsibility under BIM levels that must be identified in the contract conditions. The levels of BIM use 4D for time measurement and 5D for cost measurement as an integrated BIM package to enable its application over the whole lifecycle of a construction project. In order to effectively implement a comprehensive approach using BIM for analysing potential construction claims, it is crucial to acknowledge the existing research gap in exploring the efficacy of BIM in delay claim analysis. Gibbs et al. (2013) [44] and other researchers stated that the assessment of delayed claims poses several challenges, including information retrieval and visualisation during the evaluation process [54,55]. The proposed theoretical framework for analysing claims procedures will be thoroughly validated and examined in a subsequent research paper conducted by the author. This research will be supported by real-life disputable claims cases from the KSA legal industry. Additionally, the next section provides an example from a case study to test the theoretical framework.

To use the theoretical framework in Figure 4, Scenario 1 represents the prospective method as an analysis process that takes place at the time of decision for delays or change orders to predict the likely outcomes of those compensation events related the expected delays with the associated cost, if any. For example, if a variation order is issued to change the location of a precast wall in a project, the supplier estimates that it might take 8 days to deliver the new wall, and the installation is expected to take 1 day. Consequently, when this change is incorporated into the construction schedule, it shows a potential delay impact of 9 days on the completion date. This type of analysis is known as a prospective approach, as it involves forecasting the potential impact of a delay event based on the estimated duration at the time of the event and how it could affect the contractor's programme.

In a practical case study involving the implementation of a medical warehouse project in the KSA, the corresponding author was a member of the contractor's team. The project was being executed following a traditional approach. The owner expressed the need to relocate the indoor air handling units of the air conditioning (AC) system due to storage conditions. These AC units were to be suspended on specific steel elements of the roof structure. The structural elements of the building were under fabrication and the contractor's team referred to the supplying factory for the structural elements of the building with the owner's modification request. The factory accepted the request with an additional cost of change of USD 37,500 and assured that the alteration would be completed within a timeframe of 2 weeks. However, the 2 weeks of the delay impact were accepted by the project team as it would not affect the overall deadline. Contrary to expectations, the steel factory informed the project team that the delivery of the modified steel structure would encounter a significant delay of 2 months. Consequently, the overall project would experience an equivalent delay. The factory justified its lack of awareness regarding the potential ramifications of altering the steel sections that supported the air conditioning units with other interrelated design elements. The project was theoretically subjected to a delay claim longer than expected between the contracting parties due to a lack of proper analysis before taking the action of the change order.

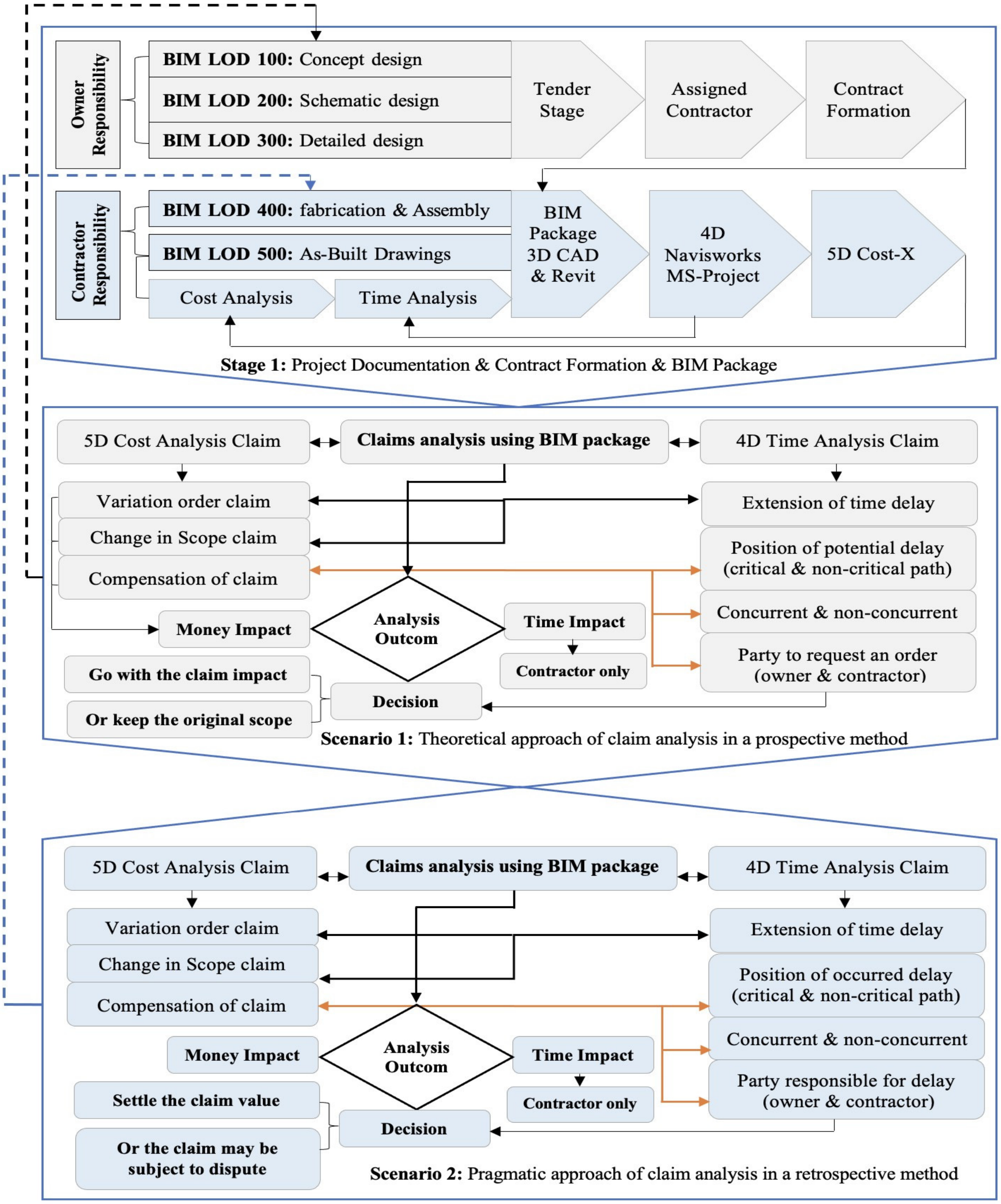

Figure 4. Flow chart created by the authors to show the claims analysis using the BIM package under prospective and retrospective methods.

The above case study was simulated prospectively using the BIM package based on Scenario 1, for which the schedule was re-analysed using Microsoft Project in conjunction with Navisworks. The simulation indicated that a projected delay of 2 weeks would not impact the project's deadline. However, the additional 45 days were not considered when considering the subsequent delay caused by the steel supplier. As a result, the delay in the steel elements also caused a delay in the provision of air conditioning units and the installation of the firefighting network. In total, the project incurred a cumulative delay of 75 days. The owner expressed that, if he had known about this consequence beforehand, he would have reconsidered the decision to modify the handling units' location and would have approached the storage conditions differently. Therefore, it should be noted that the prospective approach relies heavily on theoretical estimates rather than the hard facts of claims. In other words, prospective analyses are conducted in real time before or during the delay event. These analyses involve the analyst's best predictions of future events. They are performed while the project is still in progress and may not be relevant to forensic investigations. The method of delay analysis used for an EOT claim might have significant implications, as it can yield different outcomes. By employing prospective analysis and relying on computer-based BIM modelling and time impact analysis, the contractor may anticipate that the variation will cause a critical delay, thus warranting EOT claim.

To address the aforementioned delay and return to the real-life example from the industry, we retrospectively analysed and simulated the anticipated 75 delays. We expedited and reorganised specific activities in the schedule related to the steel elements so that they could be completed simultaneously (Start to Start and Finish to Finish). Additionally, we planned for the fabrication of the AC unit pipes to take place off site, making them ready for installation once the modified steel elements arrived on site. Furthermore, extensive negotiations and virtual meetings were conducted between the contractor team and the steel supplier in order to minimise the delays to just 50 days. The main contractor and the steel supplier reached an agreement that 50% of the modified steel elements would be delivered to the site within 30 days of the change order. Subsequently, approximately 50% of the steel structural elements would be erected onsite, followed by the sequential installation of 50% of the AC units in their new locations. Based on these analyses, 25 days from the total delayed period were reduced. Therefore, Scenario 2 in the theoretical framework in Figure 4 evaluates the delay retrospectively, after its complete impact has been felt. More precisely, the retrospective approach to delay analysis relies on factual evidence to determine its findings. By comparing the original plans to the actual events that took place during construction, this method offers a more accurate understanding of the impact of the delay. Its conclusions are derived from facts rather than theories, providing a clearer and more precise assessment [53]. The difference between the prospective and retrospective methods can be significant, especially if they determine whether liquidated damages for delay need to be paid. The issue becomes more complex and accurate during adjudication, arbitration, or court proceedings, where the full impact of events is unknown.

After the completion of a project, all project data, such as schedules, correspondence, and project records, is accessible through a retrospective approach. This guarantees a thorough and precise dataset for examining delays, rather than depending on approximations or forecasts during the construction period. The retrospective technique facilitates the comprehensive documenting of events, modifications, and delays during the whole duration of the project. Thorough documentation enhances a more thorough comprehension of the reasons and consequences of delays, establishing a solid basis for presenting claims effectively. From a legal standpoint, following the retrospective approach, the parties involved in a dispute can better support their legal arguments by utilising comprehensive data obtained after the project. This leads to stronger and more defensible claims or defences during legal proceedings, ultimately increasing the likelihood of a favourable outcome for the aggrieved party.

As shown in the Figure 4, the outcomes of analysing claims procedures under the prospective approach often lead to accepting the forecasted delays or maintaining the original decision unchanged. However, the analyses in the prospective approach may retrospectively lead to a corrective action, in which the programme can be modified to reduce the potential delays when the project is totally affected. In contrast, in the retrospective approach, a claims analysis may result in a claim settlement or escalate to disputes. Therefore, the following sections provide a detailed analysis based on a real-life case study, exploring both the prospective and retrospective approaches in greater depth.

3.1. A Real Case Study: Simple Programme for Scenario 1A: An As-Built vs. As-Planned Programmes

We present the real case study of Walter Lilly v Mackay, presented by Ewen Maclean [56]. A simple scenario (Scenario 1) included five milestone activities, substructure, superstructure, finishing, MEP, and handing over, which were expected to be completed by the end of week 15 in the prospective situation. In Scenario 1a in Figure 5, the as-built programme showed a delay of 3 weeks compared to the as-planned programme, resulting in completion at the end of week 18 [56]. The substructure and superstructure activities were completed on time, while the finishing activities were delayed by 3 weeks, and the subsequent activities were completed within their original duration. Therefore, a compensation event lasting 3 weeks was required, as plotted on the programme at the end of week 6. This event accounted for the delay in starting the finishing activities and the overall delay of 3 weeks for completion. In the prospective analysis, the programme started with the same plan and was updated until just before the compensation event occurred [56]. Figure 5 indicates that the as-planned programme is still scheduled to be completed by the end of week 15, with no delay just before the compensation event.

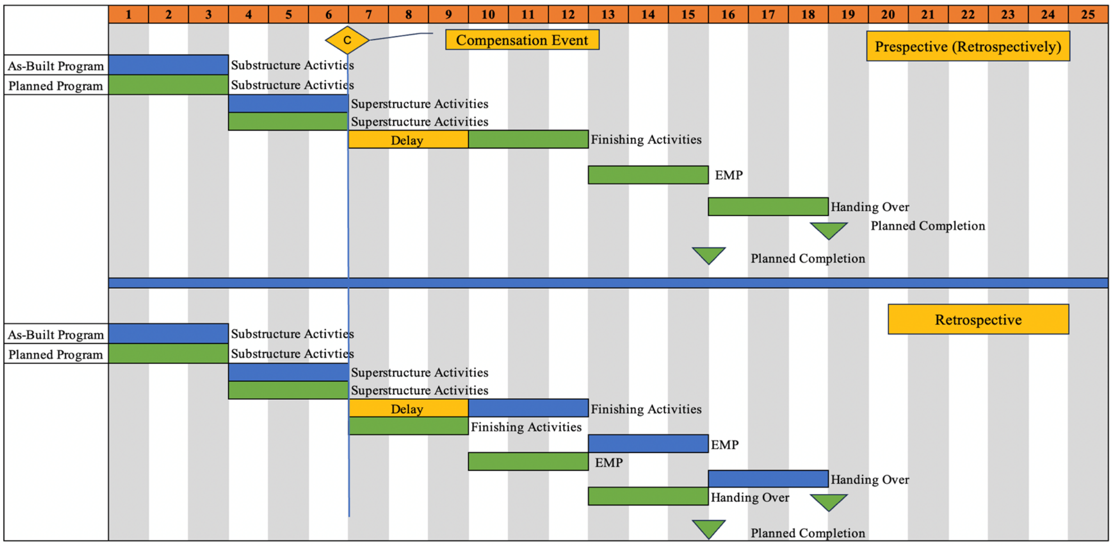

Figure 5. Scenario 1A: prospective vs. retrospective analyses with the benefit of hindsight, adopted from [56–58].

3.2. Developed Programme for Scenario 1B: As-Built vs. as-Planned Programmes

In the retrospective approach, with the benefit of hindsight, the first scenario is developed in Figure 6 by considering the impact of the compensation event on the programme. The compensation event had a 3-week delay, pushing the planned completion date to the end of week 18. This aligns with the completion of the as-built programme and demonstrates the same result as the retrospective analysis. However, a prospective analysis carried out contemporaneously, without the benefit of hindsight, would have forecasted a 6-week delay, as shown in Scenario 1B in Figure 6, as this process would not have been able to forecast that the compensation event would only cause a 3-week delay. This would have pushed the planned completion to the end of week 21, resulting in a different outcome to that of the as-built programme or retrospective analysis. Therefore, prospective and retrospective analyses do not always yield the same result in every situation, unless the forecast delays match the actual delays [53,56].

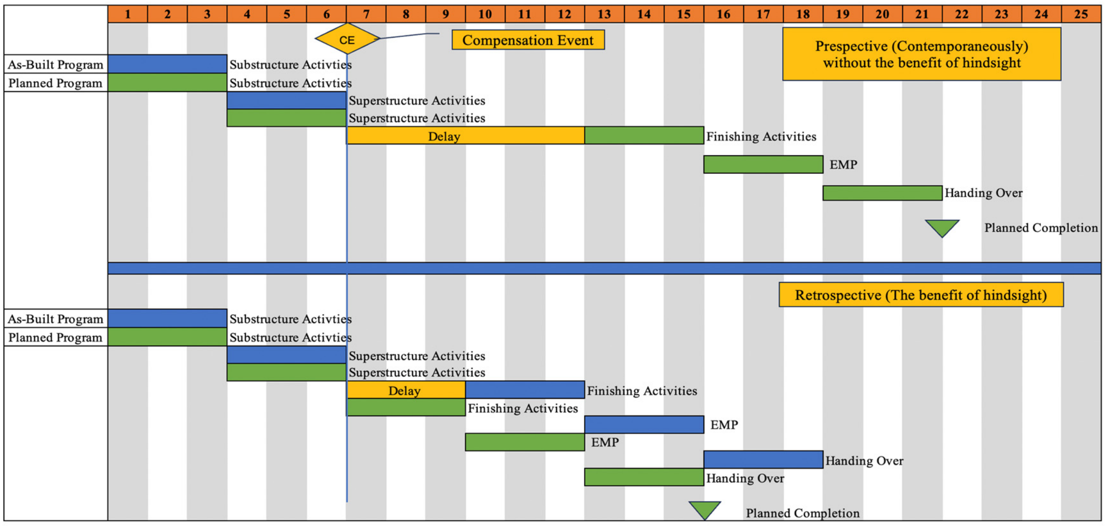

Figure 6. Scenario 1B: prospective vs. retrospective analyses without the benefit of hindsight, adopted from [56–58].

3.3. Series of Presented Developed Programmes as Accepted Programmes: As-Planned vs. As-Built Programmes

The prospective and retrospective analyses are explained in more depth in these series scenarios concerning the scenarios mentioned above. The first accepted programme is scheduled to be completed by the end of week 15, with the completion date set for the end of week 19, as shown in Figure 7. A terminal float of 4 weeks is assumed to represent the period between the planned completion and the completion date, for which no delays are attributed to either the contractor or the employer. When programme No.1 is updated, it becomes apparent that the substructure and superstructure activities were completed 1 week later than planned, causing a delay in the overall project schedule from week 15 in programme No.1 to week 16 in the updated programme (No. 2) as shown in Figure 8. In the second accepted programme, a compensation event 1 is presented to have a duration of 6 weeks but only took 3 weeks in the updated programme (No. 3), as shown in Figure 9. In order to analyse its effect, the updated programme is considered relevant to the time when the second accepted programme was created. This delay occurs as there are no compensation events within this period of work. The completion date remains unchanged at the end of week 19, but the terminal float is reduced from 4 weeks to 3 weeks. In other words, the contractor is responsible for the 1-week delay to the project. This holds for both the prospective and retrospective situations, as indicated in the tables in the top right-hand corner of each chart.

In the prospective situation, if the approved programme No.2 undergoes an update for progress and experiences a delay of 6 weeks that impacts the superstructure activities, it results in a 6-week extension to the planned completion from week 16 to week 22. Accordingly, the completion date is also shifted by 6 weeks, from week 19 to week 25. As a result, the terminal float remains unchanged at 3 weeks, and the responsibility for the 6-week delay lies with the employer since the programmes are still based on a prospective situation. At this stage, we cannot assess the situation retrospectively since we do not have the benefit of hindsight regarding what happened. When analysing the accepted programme No. 3, as shown in Figure 9, the assessment of compensation event 1 was incorrect. It only took 3 weeks to address the event, resulting in a shift in the planned completion from week 22 to week 19. Consequently, in the prospective analysis, the terminal float increases from 3 to 6 weeks, as the retrospective analysis does not allow for changing the completion date backwards. We show that the 3-week delay took place in the superstructure activities, which pushes the planned completion from week 16 to week 19. Therefore, the completion date is moved from week 19 to week 22. Hence, in scenario No. 3, the employer is accountable for a 3-week project delay, while the terminal float remains at 3 weeks. In summary, there is a discrepancy in the completion date and the terminal float between the two different analyses.

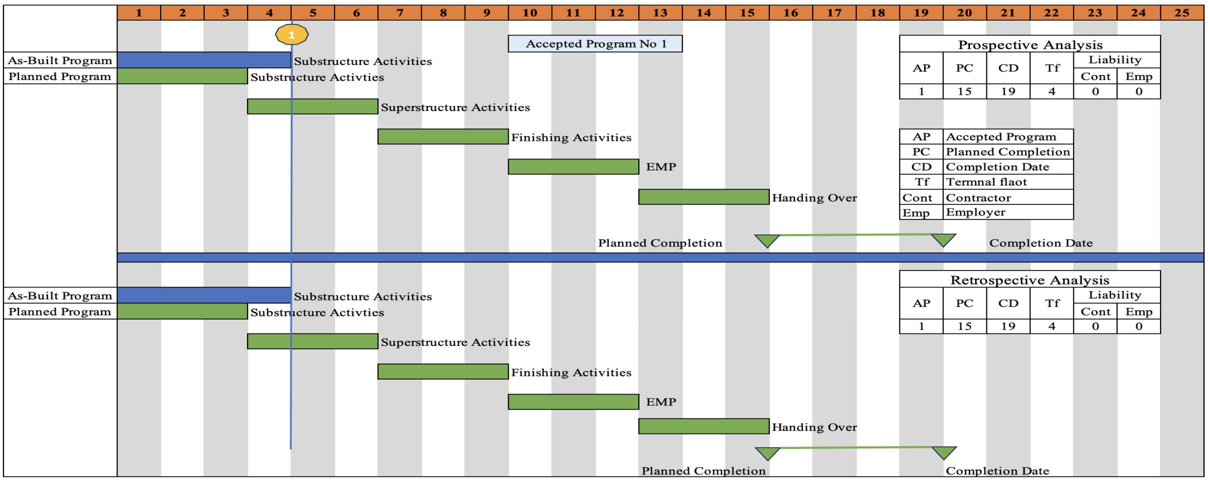

Figure 7. Accepted programme No. 1, adopted from [56–58].

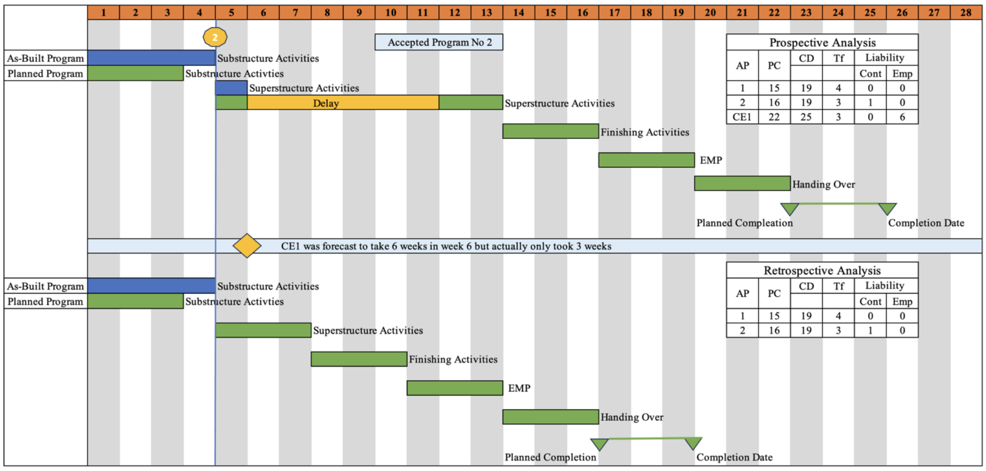

Figure 8. Accepted programme No. 2, adopted from [56–58].

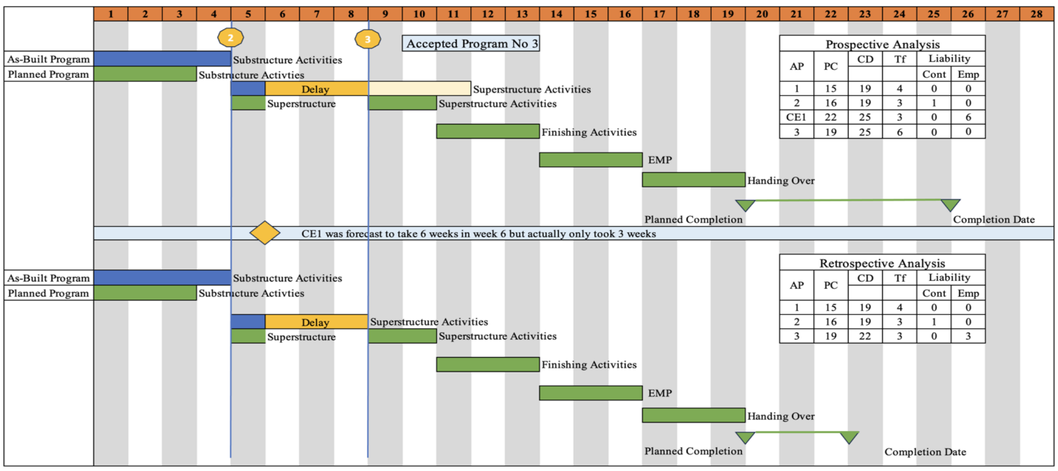

Figure 9. Accepted programme No. 3, adopted from [56–58].

In programme No. 4, the compensation event No. 2 is presented at the beginning of week 11, which was initially expected to take 4 weeks but was completed in just 2 weeks, as shown in Figure 10. In order to assess its impact on the prospective situation, the accepted programme No. 3 is to be updated, resulting in 4 weeks' delay in the superstructure activities. Consequently, the planned completion is pushed back by 4 weeks, moving from week 19 to week 23. The overall completion date also shifts from week 25 to week 29, and it should be noted that the employer bears the responsibility for this four-week delay. Again, since we are still in a prospective situation, we cannot discuss the retrospective situation when considering accepted programme number 4. The assessment shows that the impact of compensation event number 2 was once again miscalculated. This resulted in a two-week delay, shifting the planned completion from week 23 to week 21. In this prospective scenario, the terminal float increases from 6 to 8 weeks, as the completion date cannot be revised backward in the retrospective situation. We simply show the two-week delay in the finishing activities, which ultimately pushes the planned completion back from week 19 to week 21. The completion date is moved from week 22 to week 24. The employer is responsible for the 2 weeks' delay of the project. The terminal float remains at 3 weeks. In summary, there is a further divergence in the completion date and the terminal float under the two different analyses.

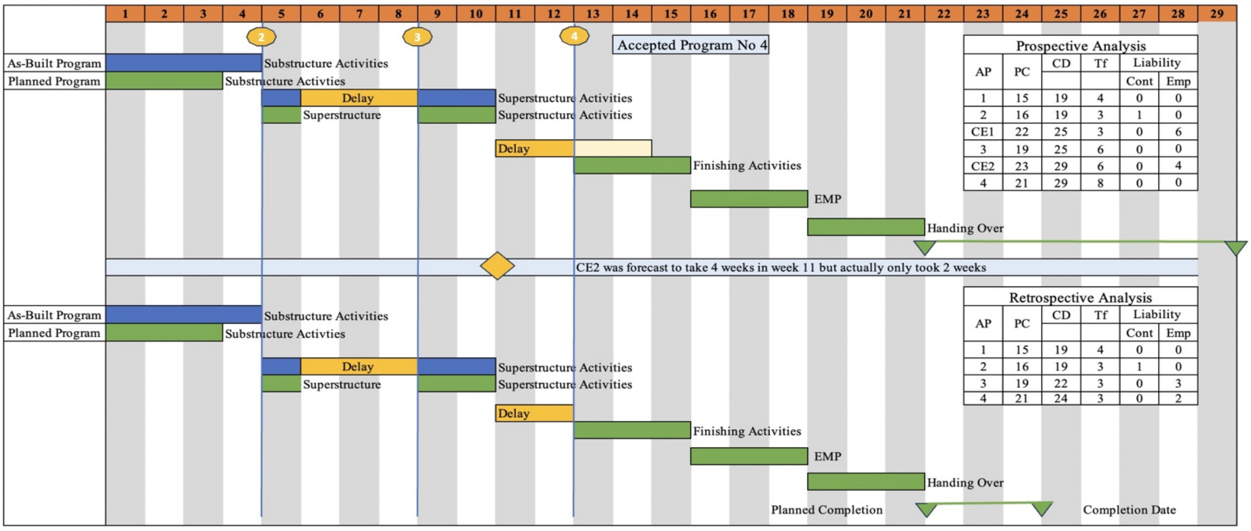

Figure 10. Accepted programme No. 4, adopted from [56–58].

In the accepted programme No. 5 in Figure 11, a compensation event is examined later and is determined to be under-assessed. Compensation event No. 3 is introduced in week 17, which was initially assessed to take 2 weeks but took 4 weeks. In order to analyse its impact in a prospective scenario, we refer to the accepted programme at that time—accepted programme No. 5. Notably, there is no further delay at this point. It could be contended that it is imperative to demonstrate the impact of the implemented compensation event and the progress achieved on the activities and remaining work. Even in the straightforward scenario presented, the programme starts to lack clarity. The main purpose of presenting a series of simple programmes is to ensure that, when a programme involves a high volume of activities and numerous compensation events, it accurately reflects the effects of these events and the progress made to create a realistic plan. Without using the BIM model, which incorporates cost and time analyses, the programme is disorganised and dysfunctional. This can result in unreliable assessments of compensation events, particularly when dealing with concurrent effects [56].

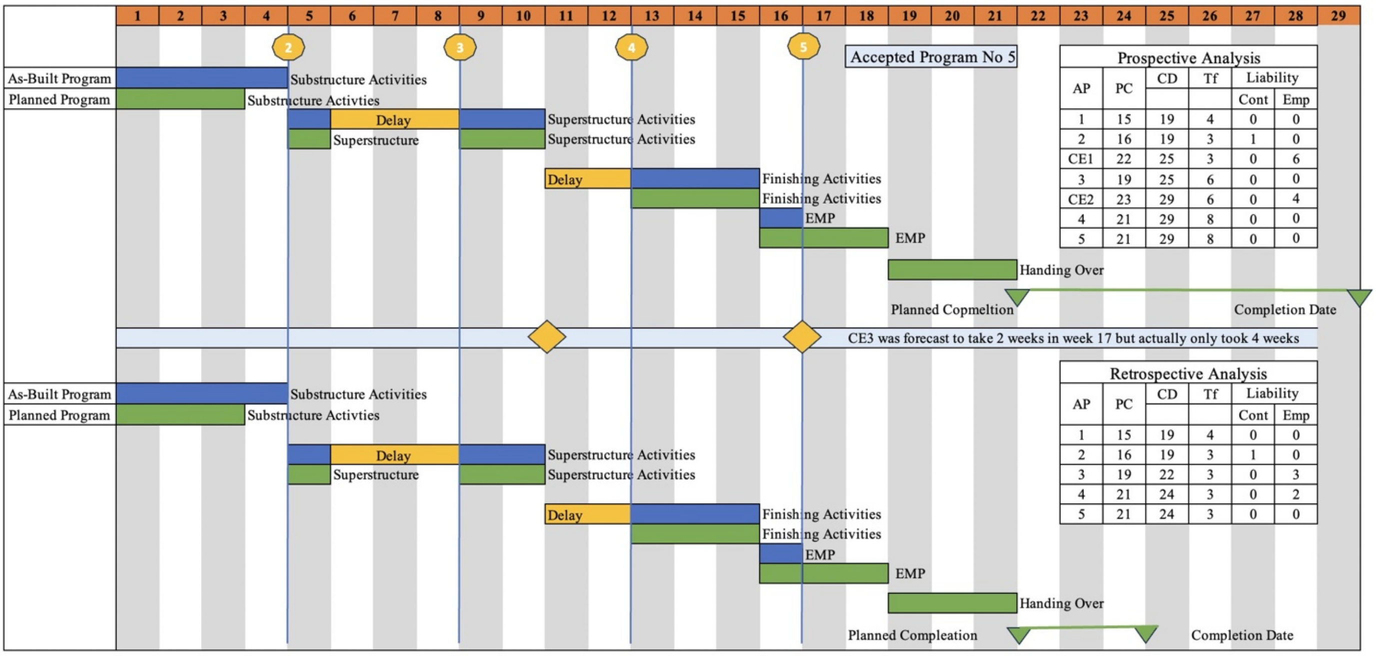

Figure 11. Accepted programme No. 5, adopted from [56–58].

3.4. Summary of the Literature Review with an Explanation of the Research Gap

The literature review examines claims management procedures in the construction industry, highlighting the continued prevalence of traditional practices, particularly in the KSA. These practices rely on manual analysis and documentation, lacking the use of advanced technology to analyse the time and cost and accurately store claim documentation. In this research, the authors proposed a holistic approach consisting of four simplified steps, as illustrated in Figure 1. However, it is important to note that, despite the visualisation provided in the figure, the traditional practice remains impractical in reality.

This research investigated an alternative approach using the BIM package to resolve conflicts related to claims, such as time consumption, accurate valuation, and trust in the claim outcome. A simplified conceptual framework consisting of three steps was proposed to analyse claims based on two scenarios, as illustrated in Figure 4. The proposed approach emphasises the required levels of BIM integration with the appropriate software. Additionally, Figure 4 presents Scenarios 1 and 2, which facilitate the analysis of concurrent delays from various perspectives. These theoretical delay analyses, detailed in Sections 3.1–3.3, highlight the complexity of analysing concurrent delays and assessing the rights of each party involved in the claim process.

Similar studies have investigated the usage of BIM in claims procedures from various perspectives, as summarised in Table 2. These studies proposed different analyses and approaches regarding how to handle claims and presented conceptual frameworks with case studies to facilitate the claims procedure. However, despite the importance of these studies, many of them appear complex and difficult to follow, particularly for claims and contract managers in construction projects. This can be due to the fact that not all claim or delay analysts or even contract managers have an extensive academic background to rely on when engaging with comprehensive research papers with data statistics to derive the benefits of a claim outcome. Consequently, a lack of studies on the KSA construction industry and how to present a claim under traditional practices in a simple manner (Figure 1) were identified as gaps in our research. For example, the first step in Figure 1 introduces the fundamentals of claims, providing a clear identification of the bases and the right to claim for the reader. The subsequent steps (2, 3, and 4) highlight the claim preparation cycle, along with the time notice under the contract used in construction projects. Therefore, the purpose of this study was to introduce a realistic conceptual framework that simplified the procedures for claims under traditional approaches, while also suggesting an alternative approach for easily incorporating the BIM package to resolve claims as a new approach (Figure 4).

Table 2. Similar studies have investigated the integration of BIM in construction claims procedures.

Paper Topic	Objectives of the Study	Reference
A BIM-based construction claims management model for the early identification and visualisation of claims.	Introducing a claim management model based on claims that can be visualised in BIM models.	[1]
BIM-based claims management system: a centralised information repository (T) for the extension of time claims.	The feasibility of using BIM to provide input information for an expert claim management system.	[5]
Claims and dispute resolution using BIM technology and VDC process in construction contract risk analysis.	It focuses on utilising BIM technology to develop a BIM-based claims management system to manage EOT claims.	[48]
A conceptual framework for developing a BIM-enabled claim management system.	Analyses the impacts of changes and delays on the schedule and cost of construction projects using the BIM platform.	[59]
BIM-based framework to quantify delays and cost overruns due to changes in construction projects.	Proposes a BIM approach to control conflict causes before the occurrence of a dispute.	[60]
Building information modelling in construction conflict management.	Reduce claims, disputes, and litigation throughout the construction process.	[61]
Dispute resolution: can BIM help overcome barriers?	Investigate benefits during claims and the resolution of disputes based on a BIM model.	[62]
Improving construction claims management using building information modelling (BIM).	Provide a schedule delay analysis method and tool that uses the correct design, estimating data from the BIM database.	[63]
Integrating BIM in construction dispute resolutions: development of a contractual framework.	To identify, analyse, and classify the legal implications of integrating BIM into construction dispute resolutions and determine the BIM-enabled contract terms.	[64]
Potential applications of BIM in constructions, disputes, and conflicts.	Defining the maturity levels of BIM, which are used to indicate the elements and benefits of BIM.	[65]
A blockchain information management framework for construction safety.	To address the knowledge gap by aiming to create an innovative information management framework for construction safety processes using blockchain technology.	[66]

4. Research Methodology

The methodology applied in this research is explained in three phases in the subsections below, and this is structured in stages, shown in Figure 12. This methodology is primarily based on an extensive review of the relevant literature with a theoretical analysis of delays for claim management cases and a field survey questionnaire. In addition, four hypotheses were assumed in this study to test the given conceptual framework in Figure 12 with additional tests from the field survey. Therefore, the purpose of the field survey was to assess the levels of awareness and knowledge of using BIM in the construction industry, especially in the KSA. Additionally, it aimed to evaluate the capability of construction organisations to implement the BIM application package in resolving claims in construction rather than relying on traditional practices, as shown in Figure 1. The investigation of this study focused on the response replies from the KSA industry, with their responses indicating if it was demanding to implement a BIM package to resolve claims in dispute resolutions. Therefore, the proposed conceptual framework shown in Figure 4 is presented as the appropriate approach to analyse the delays and determine the value of claims in the case of an occurrence.

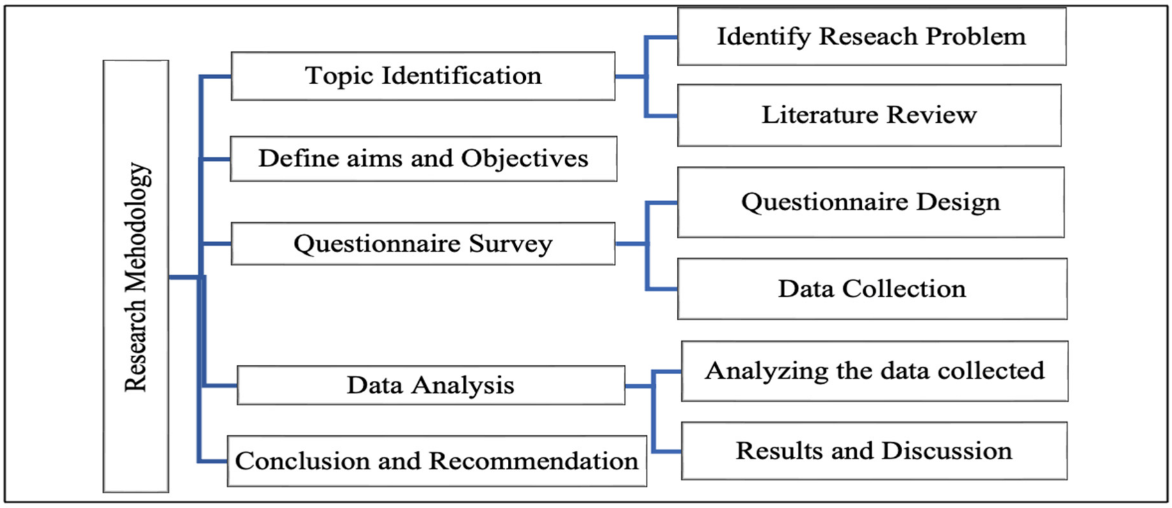

Figure 12. Research methodology.

4.1. Phase 1: Research Background and a Review of the Previous Literature

This was achieved by conducting a thorough literature review to provide a comprehensive summary of any relevant research that aligned with the background of this study. Moreover, a historical analysis of the literature was carried out to explore the factors, causes, and origins of disputed claims in the construction industry, both in general and specifically in Saudi Arabia. The existing studies on BIM technology were critically examined in general and specifically in Saudi Arabia, as shown in Table 2. In order to select the claims management process for this study, it was necessary to identify the source of claims and the most frequently occurring claims in construction projects. Thus, seven significant sources of claims and 50 claims factors that appeared most frequently were investigated in the recent literature, as conducted by the authors of this study [53]. Within those recent studies, a compilation of the most reported sources of claims, originating from both contractors and the owners involved in construction projects, was derived.

4.2. Phase 1: Data Collection from the Field Survey as Primary Data

The primary data were collected from the construction industry through a questionnaire survey distributed among relevant practitioners. The survey was designed using the Survey Monkey platform that was used to send the questionnaire to 120 practitioners. In the population analysis, the number of selected practitioners ranged from 118 to 123, as indicated by Formulas (1) and (2) in Phase 3. The questionnaire was distributed in the construction industry in Saudi Arabia. The scope expanded to include the USA and Egypt to enhance the study's credibility and overcome any potential limitations arising from the limited number of respondents from Saudi Arabia. The number of targeted responses was identified based on the survey population analysis in Phase 3 of this methodology. The questionnaire was sent to those participants who had at least 10 years of experience or more in construction claims management and familiarity with BIM, its tools, and its uses in construction and project management. The targeted audiences ranged from employees from contracting and consulting companies to BIM managers and academics. A total of 56 participants were found to have these requirements in the KSA construction industry, forming the origin of the study; this was possibly due to the limitation of BIM use in this field. In addition, another eight practitioners responded from the USA, and 15 practitioners responded from Egypt, so the total number of respondents reached 79 practitioners.

4.3. Phase 1: Survey Population Selection and Sample Size Calculation

The targeted research sample for this study included professionals with a good knowledge of and experience in BIM technology and a working specialisation related to the AEC industry. This included civil engineers, architects, project managers, BIM managers, and claims managers; it was impossible to calculate the total number of the targeted population precisely in the construction industry. Therefore, the researcher, with the support of experts working in the construction industry, consulted with others to provide an accurate number for the required research population. Based on the available online data, there are approximately 234,738 engineers registered with the Saudi Council of Engineers, making them the primary workforce in the construction industry of the KSA. In order to rationalise the actual population, only a figure of 200,000 (as a statistical calculation) from the total population was used to support this study. We used the Cochran formula to determine the accurate sample size. This formula allows researchers to estimate the number of individuals needed in a study to ensure statistically meaningful and reliable results. It considers the desired level of confidence and margin of error when estimating a proportion within a population. Slovin's formula is another method commonly employed to determine the sample size for research studies, particularly in the context of survey research. It is often used in scenarios where obtaining a complete list of the entire population is not feasible, and researchers need to rely on a representative sample; the formulas are shown as follows:

Formula 1: Cochran formula:

$$\mathrm{n} = \frac{\mathrm{z}^2 * \mathrm{p} * \mathrm{q}}{\mathrm{c}^2} \tag{1}$$

z = Z value, which is taken as 1.96 for a 95% confidence level; p = percentage for picking a choice, expressed as a decimal, taken as 0.5; q = 1 − p; c = margin of error, taken as 9% = 0.09; N = total population, taken as 200,000; and n = sample size.

By applying the formula, we obtained the following: $n = \frac{1.96^2 * 0.5 * (1-0.5)}{0.09^2} = 118.$

Formula 2: Slovin's formula:

$$n = \frac{\left(\frac{N}{1}\right) + N}{C^2} \tag{2}$$

C = margin of error, taken as 9% = 0.09; N = total population, taken as 200,000; and n = sample size.

By applying the formula, we obtained the following: $\mathrm{n} = \frac{\left(\frac{200000}{1}\right)+200000}{0.09^2} = 123.$

5. Data Collection and Analysis

This section analyses all the data gathered from the responses to the questionnaire survey to achieve the desired outcomes of this research study. The findings are presented in written form, comprising explanations, descriptions, percentages, tables, and charts. Graphical representations were employed due to their ability to enhance the comprehension and clarity of the results. Moreover, to facilitate a better illustration and presentation of the findings, the traditional practice and the assumed automated method of claims management were illustrated in categories based on the identified patterns in each section of this study.

Respondents Profiles

The targeted practitioners were selected based on Formula (2) in the Methodology section; the total selected number was 123 practitioners, and 79 respondents completed the questionnaire. Most were from contracting companies, while the rest were from consulting firms. A few participants were also in positions related to clients. The respondents had diverse academic and field experiences in the construction industry, ranging from 1 to 35 years, as shown in Table 3. The study included the Likert scale in the questionnaire survey, allowing the qualitative data to be quantified, and the open-ended questions were designed to facilitate a statistical analysis of the survey responses. This allowed the practitioners to choose their answers based on whether they agreed, strongly agreed, disagreed, strongly disagreed, or neither agreed nor disagreed, as shown in Table 4.

Table 3. Profile of the respondents; a total of 79 practitioners with a variety of experience in the range of 1–35 years.

Position	Organisation Type	No. of Responses	% of Respondents	Years of Experience
Civil engineers	Contracting	25	32%	1:15
Contract administration	Contracting	15	19%	5:10
Claims managers	Dispute resolution	13	16%	10:15
Project managers	Consultancy	9	11%	11:35
BIM managers	Contracting	17	22%	3:7
Total	Contracting	79	100%	

Table 4. Five-point Likert scale used in this questionnaire survey.

5	4	3	2	1
Agree	Strongly agree	Disagree	Strongly disagree	Neither agree nor disagree

We statistically analysed the respondents' opinions, reflecting the questions of this research paper to test the assumed four hypotheses stated. In addition, the respondents' feedback was used to measure the level of awareness of BIM implementation, especially in the KSA construction sector. Therefore, 10 specific questions were extracted from a total of 20 different questions in the questionnaire survey to analyse them based on the Likert scale; the results are presented in Table 5. The respondents were asked to select one of the five available options to estimate the frequency of each question answer. A numerical weight ranging from 5 to 1 was assigned to indicate each question frequency, with 5 representing "agree", 4 representing "strongly agree", 3 representing "disagree", 2 representing "strongly disagree", and 1 representing "neither agree nor disagree". For example, in the questionnaire, the respondents rated the answer to question No. 1 in Table 5 (How familiar are you with BIM?), for which the answer was 30 for "agree", 20 for "strongly agree", 10 for "disagree", 9 for "strongly disagree", and 10 for "neither agree or not disagree".

Table 5. Open-ended questions as part of the questionnaire survey distributed for BIM awareness.

No	Questions	Rate					
		Participants	Agree	Strongly Agree	Disagree	Strongly Disagree	Neither Agree nor Disagree
1	How familiar are you with BIM?	79	30	20	10	9	10
2	In your opinion, is there a growing awareness of BIM usage in Saudi Arabia?	79	35	25	11	3	5
3	Is your organisation actively using or planning to use BIM?	79	25	18	5	5	5
4	In your opinion, may using BIM in disputable claims reduce the degree of recourse to litigation or arbitration?	79	40	30	3	4	2
5	In your opinion, will BIM implementation reduce the overall project costs?	79	37	20	10	3	9

Table 5. *Cont.*

No	Questions	Rate					
		Participants	Agree	Strongly Agree	Disagree	Strongly Disagree	Neither Agree nor Disagree
6	In your opinion, is the implementation of BIM suitable for small- and medium-sized construction projects?	79	20	15	20	16	8
7	In your opinion, does using BIM reduce the possibility of a cost overrun and keep the original budget on track?	79	50	10	9	10	0
8	From your experience, is it recommended to include BIM technology in the documents of the Standard Form of Contracts so that claims and disputes can be analysed and relied upon for their outcomes?	79	45	20	8	4	2
9	In your opinion, will implementing BIM help improve construction project productivity?	79	35	35	5	4	0
10	Is there a growing demand for BIM usage in Saudi Arabia, Egypt, or the United Arab Emirates?	79	45	22	6	3	3

Two mathematical formulas were used to analyse the data collected from the field survey. The weighted average formula (No. 3) was used to assess the data presented in Table 4. In this formula, W represents the weight of the question factor, X represents the number of respondents who selected it, and N indicates the total number of respondents (79 in this study).

$$\sum = W * \frac{X}{N} \tag{3}$$

(W) is the weight of each question answer;
(X) is the number of respondents who were chosen, and;
(N) is the total number of respondents (79 practitioners in this study).

The formula (Formula (4)) used in the data analysis is the significance index:

$$\sum * \frac{100}{7} \tag{4}$$

For each data point, the index is calculated by dividing the column % of the crossing cell by the percentage of the whole cell and then multiplying the result by 100 and dividing it by 10, which is the total number of questions. The data analysis is explained in detail in the data analysis section and is shown in Table 5. The indexes in this range are not usually noteworthy, although they might be instructive when investigating large audiences and common traits.

In order to provide a clear sense of the importance of the answer to each question, a significance index (%) was calculated and is shown in Table 5 (based on the given weighting scores from the participants, as shown in Table 4). The results of the significance index are used in the combination of Formulas (3) and (4).

Table 6 displays the average response value for each question related to BIM as a proposed package to be used in the KSA industry. For example, in Table 4, the weighted average for Q1

(How familiar are you with BIM?) is (5 × 30 + 4 × 20 + 3 × 10 + 2 × 9 + 1 × 10)/79 = 3.65, which has a significant index of (3.65 × 100)/10 = 36.45%.

Table 6. The weighted average of the responses in the questionnaire survey.

No	Type of Questions Related to BIM Awareness	Average Responses (%)	Ranks
1	How familiar are you with building information modelling (BIM)?	36.45%	7
2	In your opinion, is there a growing awareness of BIM usage in Saudi Arabia?	40.38%	5
3	Is your organisation actively using or planning to use BIM?	28.73%	9
4	In your opinion, may using BIM in disputable claims reduce the degree of recourse to litigation or arbitration?	43%	2
5	In your opinion, will BIM implementation reduce the overall project costs?	39.42%	6
6	In your opinion, is the implementation of BIM suitable for small- and medium-sized construction projects?	32.91%	8
7	In your opinion, does using BIM reduce the possibility of a cost overrun and keep the original budget on track?	43.8%	1
8	From your experience, is it recommended to include BIM technology in the documents of the Standard Form of Contracts so that claims and disputes can be analysed and relied upon for their outcomes?	42.9%	3
9	In your opinion, will implementing BIM help improve construction project productivity?	42.8%	4
10	Is there a growing demand for BIM usage in Saudi Arabia, Egypt, or the United Arab Emirates?	43%	2

The Q2 (in your opinion, is there a growing awareness of BIM usage in Saudi Arabia?) calculation is (5 × 35+ 4 × 25 + 3 × 11 + 2 × 3 + 1 × 5)/79 = 4.04, which has a significant index of (4.04 × 100)/10 = 40.38%.

The Q3 (Is your organisation actively using or planning to use BIM?) calculation is (5 × 25+ 4 × 18 + 3 × 5 + 2 × 5 + 1 × 5)/79 = 2.87, which has a significant index of (2.87 × 100)/10 = 28.73%.

The Q4 (In your opinion, may using BIM in disputable claims reduce the degree of recourse to litigation or arbitration?) calculation is (5 × 40 + 4 × 30 + 3 × 3 + 2 × 4 + 1 × 2)/79 = 2.06, and its significant index is (4.29 × 100)/10 = 43%.

The Q5 (In your opinion, will BIM implementation reduce the overall project costs?) calculation is (5 × 37 + 4 × 20 + 3 × 10 + 2 × 3 + 1 × 9)/79 = 3.92, and its significant index is (3.92 × 100)/10 = 39.24%. However, all of the results of the questionnaire are presented in Table 5 in Section 6.

6. Discussion of the Literature Review and Results

The first section of the literature review examined claim management procedures in construction projects. It emphasised the importance of including a clear claim identification process in the contract conditions between the parties involved. The failure to include a claim identification process in the contract could result in conflicts regarding a claim's measurement and financial assessment. Claims identification and how to solve claims are identified under standard forms of contracts, such as FIDIC, JCT, and NEC3. The issue of professionally settling construction claims in the KSA construction industry is still complex. One of the main reasons for this complexity is the use of different contract forms in the public and private sectors. The local standard form (PWC) used in the public sector is considerably tailored from the FIDIC general conditions, while the private sector relies on traditional contract forms tailored to each project. However, the reliance on traditional contracts has inherent risks and often leads to disputes and conflicts between the parties involved. Claims can be analysed using the traditional approach, which does not rely on comprehensive software, such as BIM packages that includes 4D whether Primavera or Microsoft Project with Navisworks and 5D such as Cost-X. It requires precise sequences, professional claims managers, and clear communication channels among all contracting parties. The absence of a process for claim identification, analysis, and submission could have a subsequent impact on the expected outcome. For instance, under the FIDIC standard form, the entitled party to a claim must notify the engineer within 28 days from when they deem themselves entitled to the claim (as displayed in Figure 1). The failure to submit a claim under the FIDIC within this time frame can result in a significant loss of claim rights. Additionally, if the supporting documents of a claim are unclear, the entitled party can lose the claim due to a lack of evidence or difficulty in demonstrating causation. The mention of the 28-day maximum period under the FIDIC contract is necessary because, in certain cases, analysing a complex claim following the traditional route, particularly when assessing delay-related claims, can be time-consuming from the point of claim awareness.

The BIM package is essential for dispute resolution, delay and time analyses, and cost analysis to improve the claims analysis as an alternative method to the traditional approach. Despite minor obstacles when using BIM in the construction industry, specifically in the KSA, it is evident that BIM can be used by the involved parties to collaborate in construction via the web or common data sharing with each other. For example, when a project owner requests a change in the contractor′s scope under the BIM process, prompt action to update the drawings can significantly impact the project timeline and budget. This will allow the owner to decide whether to proceed with the changes and approve the associated cost implications. Risks are inherent in the construction industry, and no project is risk-free. Therefore, the risks associated with BIM can arise from various factors, such as the ownership of project information, responsibility for BIM levels, and the reliability of data sharing. For instance, the owner or engineer is responsible for preparing BIM level 300, while the contractor is accountable for submitting BIM levels 400 and 500 [53]. In addition, a research paper examined the successful construction management process to mitigate the potential risks in construction. These processes utilised blockchain technology to systematically gather, organise, and disseminate a substantial volume of data. These data included stakeholders' safety records, review operations, risk evaluation analyses, daily reports, preventative management, incident reports, and post-incident investigations [66]. However, to integrate data management sharing, the contracting parties can sign a single agreement for using and sharing BIM, allowing for the precise identification of each party's liabilities.

Although this research paper primarily discusses the benefits of BIM packages in claims management, it is important to recognise that the advantages of BIM can also extend to other related factors, such as energy efficiency and sustainable design [58]. A recent study stated that BIM enabled the design and analysis of energy-efficient and sustainable buildings. Integrating green building practices in rural housing projects contributes to climate resilience. BIM facilitates accurate quantity take-offs and material tracking, thereby reducing disputes related to materials [67]. BIM allows for the lifecycle analysis of materials, aiding in the selection of eco-friendly and climate-resilient construction materials. BIM assists in change tracking and visualisation, supporting effective claims management. Additionally, BIM can be utilised to design structures that are resilient to climate-related disasters, such as floods or storms, thereby mitigating the risk of damage and associated claims [67].

When it comes to reducing claims in construction using BIM, there are several factors that must be taken into consideration in addition to the delay and cost analyses, which are the focus of this study. Recent research focuses on the Philippine construction industry has established guidelines to simplify and clarify the instructions for designing and constructing disaster-resistant buildings [68]. This addresses the lack of a standardised approach to residential construction that is accessible to most homeowners in the Philippines. Given the ongoing threat of climate change in at-risk areas, like the Philippines, it is crucial to prioritise the development of local capabilities to enhance the resilience of housing [68]. The study argues that implementing technical advances, such as BIM technologies, is crucial for ensuring efficiency and enhancing safety in construction projects. However, there are still obstacles to fully utilising the capabilities of these technologies, particularly at the organisational level. Offering evidence-based treatments and technical knowledge can help promote the development of resilience. Strengthening the understanding and application of the guidelines in residential construction in earthquake and typhoon-prone regions will enhance the structural integrity of houses and bolster the nation's resilience. To enhance the role of technical knowledge in fostering resilience, it is advisable to focus on building local capacities [68]. This can be accomplished by providing technical support to local builders and homeowners.

Recent research indicates that effective collaboration among key actors, especially governmental bodies, institutions, and local influencers, is crucial for implementing sustainable strategies to enhance housing resilience. The advantages of BIM are not limited to reducing claims resulting in extensions of time or changes in orders; their advantages can be extended to integration with other activities. A recent study stated that the incorporation of low-cost stochastic computing-based fuzzy filtering for image noise reduction in BIM applications for construction projects could have significant implications. It can enhance the image quality in BIM documentations by utilising the noise reduction capabilities of stochastic computing-based fuzzy filtering [69]. Having high-quality images is particularly crucial in BIM for visualisation, project communication, and documentation purposes. In addition, the improved image analysis for site assessments can result in noise reduction, leading to clearer and more precise data for site assessments and analyses. Construction professionals can utilise these clearer images to analyse site conditions, assess progress, and make informed decisions throughout the project lifecycle [70]. A real example is at a private international school in KSA, where the corresponding author of this research was involved in the teamwork of that project. The project was delivered, and the operation team discovered noise and echo in the theatre that disturbed the students during their music classes and training. That problem occurred due to a lack of integration of the relevant specifications and documents for the theatre finishing. The case of that example was one of the reasons that encouraged the author to investigate the importance of the BIM package as an alternative to traditional management practices in construction projects to reduce claims and enhance the construction process.

To ensure the proper implementation of BIM in the KSA industry with minimal obstacles, specific guidelines are crucial. The absence of these guidelines can impede the implementation process. Factors, such as the country's regulations, organisational capability and capacity, standardisation, training, and motivations, should be taken into consideration for successful implementation. Nevertheless, it is crucial to acknowledge that the current regulations fluctuate considerably among different countries, posing challenges for professionals in the AEC sector [70]. Hence, it is crucial to establish uniform and nation-specific norms. Malaysia has demonstrated praiseworthy dedication to the adoption of BIM, as seen by the government's creation of a National Steering Committee on BIM. In addition, Malaysia and Iran have each placed importance on specific factors when it comes to implementing BIM. Malaysia has concentrated on creating a thorough implementation plan, while Iran has emphasised the allocation of adequate resources to satisfy the significant demand for BIM implementation [70].

In order to enhance the understanding of the BIM package and its practical application in the KSA, the authors designed a conceptual framework, which is shown in Figure 4. It provides contract administrators, claims managers, and delay analysts with comprehensive insights. Figure 4 is divided into stages: Stage 1 focuses on contract formation and delineates the responsibilities of each party involved. It is the owner's duty to prepare project documents that adhere to BIM level 300, ensuring that bidders can accurately price the project and minimise hidden risks. Once the winning contractor is selected, he or she will further develop the BIM package, advancing it from level 300 to level 400, which covers the production and shop drawings with all relevant information. This upgraded package demonstrates the cost and time information for each component of the project. Stages 2 and 3 in Figure 4 present the prospective and retrospective methods for handling expected claims related to the extension of time (EOT), additional cost, or both. The main difference between the prospective and retrospective methods lies in the timing of the analysis. Prospective analysis is typically conducted in advance before the occurrence of the compensation event. This aims to identify (theoretically) the expected extension of time and associated costs when the owner needs to issue a variation order or make changes to the project scope under the prospective methods. By doing so, the owner can make informed decisions without potential conflicts with the contractor, as the need for additional time and costs will already be agreed upon in advance, even in the event of a project extension, without the benefit of hindsight. One benefit of prospective analysis is that time-impact-related delays can be accelerated. For instance, when retrospectively examining time impact, a prospective method may only require 3 weeks instead of 6 weeks to reduce the extension of time-related variations. According to what the contracting parties agreed to, accelerating the time may involve fast-tracking or crashing some activities.

The paper presents four accepted programmes to analyse delays in various situations, as indicated in Figures 5–12, addressing the liability of both the owner and contractor in each event, particularly concurrent delays. Claims and delay analysis under a retrospective approach are typically conducted without hindsight, which means they are carried out after the compensation event has already occurred. In this approach, there is no opportunity to minimise the time delay extension since the event has already occurred. Therefore, the primary objective of performing a retrospective delay analysis is to accurately determine the claim outcome, particularly in cases involving concurrent delays, which are more complex. Under a retrospective approach, the claim analysis can result in an amicable settlement or be disputed. Based on Figure 10, a prospective analysis revealed a compensation event for 6 weeks of superstructure activities starting from week 6, with the employer being responsible for 6 weeks of delay, as indicated in the table included in the diagram. However, the delay was shortened to 3 weeks due to acceleration. In Figure 10, a retrospective analysis indicated a delay of 3 weeks, for which the employer was liable since this could not be reduced. Most delays in construction projects in the KSA construction industry are analysed retrospectively because the industry heavily relies on traditional methods instead of embracing the BIM package, as suggested by the authors in Figure 4. As a result, most claims-related delays and cost overruns are not settled amicably and might be resolved through arbitration or in courts due to the lack of advanced analysis with the benefit of hindsight.

In order to ensure that the findings of this study are applicable to the construction industry in the KSA (as the origin of the study, with possible extension to neighbouring countries like Egypt and the United Arab Emirates) and to effectively implement BIM packages, a questionnaire survey was designed and distributed. Out of the 123 individuals approached, 79 responded, representing 71% of the total sample. These respondents had varying levels of experience, ranging from 1 to 35 years, holding positions such as civil engineers, project managers, procurement managers, and contract administrators. The majority work for contracting companies, while others operate in consultancy and business development. The main purpose of the survey questionnaire was to test the four hypotheses assumed in the study that focus on the significant difference between the traditional approach and BIM. In addition, the survey questions tested the level of awareness of BIM implementation in the KSA to validate the proposed framework for resolving claims under BIM use. The selected respondents in the questionnaire survey were asked 10 questions related to BIM integration in the KSA, and the answers are shown in Table 6.

The percentages of the respondents seem similar to those shown in Table 6, and the authors comment that there is a willingness in the Kingdom of Saudi Arabia (KSA) to adopt BIM packages, focusing on adding BIM to the contract conditions. It is also noted that BIM can be implemented in small- and medium-sized companies, according to nearly 33% of the respondents. While there may be concerns about the costs involved for smaller companies, it is important to consider the potential impact of claims in the construction industry, which can reach up to 5–7% of the project budget [52]. In comparison, the cost of implementing BIM is estimated to be an average of 3% of the project budget in medium-sized projects, or it could be less on a large scale that exceeds USD 40 million. The absence of BIM technology in the contract document may not motivate or compel the industry to adopt it, especially considering the inherent complexity of construction and the increasing number of large-scale projects in the KSA that aim to be innovative and sustainable. Therefore, as a general principle, construction projects with intricate designs are not recommended to be managed using traditional practices without the integration of BIM solutions.

7. Conclusions

This study investigated and analysed the claims management procedures used in construction projects under traditional practice, along with a suggestion of an automated methodology to be used in solving claims, especially in the KSA—the origin of this study. It highlights the importance of clear claim identification and the impact of a claim on time and money. Even though standard forms of contracts, such as FIDIC, JCT, and NEC3, offer traditional solutions to settle construction claims, they lack advanced technology such as BIM. In the KSA construction industry, resolving claims seems more complicated compared to countries such as the UK and the USA. This complexity is due to the variety of contracts that are used in the public and private sectors. The public sector uses the local form (PWC) extracted from the FIDIC with the omission of important clauses to support contractors' rights, such as payment delays from the owners' sides. The private sector uses conventional contract forms tailored to each project, posing, in some cases, the inherent risks in contract conditions.

The study investigated the importance of the BIM package, which is crucial for enhancing claims analysis in the construction industry, particularly in the KSA. It facilitates collaboration among the involved parties through web-based or data-sharing platforms. For instance, a client's or the project owner's requests for changes can result in quick updates to drawings, which impacts both the project's schedule and budget. Nonetheless, there are certain risks associated with BIM, including the ownership of project information, allocation of BIM levels, and data reliability. In order to address such risks, contracting parties can establish a comprehensive agreement for the use and sharing of BIM, ensuring clear accountability for each party involved.

The authors have created Figure 4 as a framework to enhance the understanding of the BIM package and its practical application. This visualisation provides contract administrators, claims managers, and delay analysts with comprehensive insights. In addition, the framework in Figure 4 is divided into stages, with Stage 1 focusing on contract formation and the responsibilities of each party involved. The owner is supposed to be responsible for BIM Level 300, while the contractor is responsible for preparing levels 400 and 500 [53]. Stages 2 and 3 in Figure 4 present the prospective and retrospective methods, respectively, for handling expected claims related to time extensions, cost increases, or both. The purpose of analysing such a case study is that any delay-related claims must be analysed using either a prospective or retrospective approach. The main difference between the prospective and retrospective methods lies in the timing of the analysis. Aprospective analysis is conducted in advance to identify the expected extension of time and associated costs, allowing the owner to make informed decisions without potential conflicts with the contractor. The prospective analysis also accounts for accelerated time-impact-related delays. A retrospective analysis is used when a concurrent delay occurs to assess the consumed time and cost, if any, with the benefit of hindsight. Therefore, the study presents a theoretical programme that updates the four steps (based on real-life cases) to analyse the delays in various situations, with a focus on concurrent delays and the liability of both the owner and contractor. A retrospective analysis is conducted without hindsight, aiming to accurately determine the claim outcomes, especially in complex cases involving concurrent delays. In the construction industry of the KSA, delays are predominantly analysed retrospectively due to the reliance on traditional methods instead of embracing

BIM technology. This often leads to disputes and the need for arbitration or legal resolutions for claims-related delays and cost overruns.

In order to validate this study, four hypotheses were assumed to test the proposed framework in Figure 4, and a questionnaire was created and shared with the KSA construction industry. The questionnaire extended to neighbouring countries, like Egypt and the UAE, in which BIM packages were required to be implemented, with limited responses. A total of 79 of the 123 practitioners who answered formed 71% of the total targeted sample; their experience ranged from 1 to 35 years and their answers are summarised in Table 5 in Section 6. It can be believed that the costs of BIM involved ca be a concern, but the impact of claims in the construction industry is usually in the range of 5–7% of the budget and can be more in specific cases when compared to the estimated 3% required to implement BIM [53]. In addition, the absence of BIM technology from contract documents may not motivate or compel the industry to adopt it, as construction is complex, and the KSA strives for innovative, sustainable, large-scale projects.

The paper recommends that practitioners in the construction industry in the KSA utilise BIM as a valuable process to minimise disputes and enhance overall project efficiency. This can be achieved through early adoption and training, standardisation, collaboration, clear contractual agreements, and the inclusion of specific dispute resolution mechanisms related to BIM in construction contracts. By following these recommendations, practitioners can leverage BIM to improve collaboration, reduce disputes, and enhance overall construction project efficiency in the KSA construction industry.

Future work: this study builds on a recently published paper by the authors, which examined the source and contributing factors of claims, as well as the significance of BIM use in mitigating potential claims [53]. The current study delves into claims procedures under traditional methods vs. the BIM package. The authors used a theoretical programme to develop the BIM package, which served as an alternative dispute resolution method. A subsequent future paper is planned and will be based on a real-life dispute case study from the industry, which will be analysed to show how the BIM package shown in Figure 4 is simulated to settle a disputable claim. Hence, the goal of the next paper will be closely related to the goal of this paper because it will use a real-life case study from the KSA construction industry to test and confirm the framework of the BIM package shown in Figure 4.

Limitations of this study: this study focuses on claims processes related to extensions of time and money claims in the construction industry of the Kingdom of Saudi Arabia (KSA), with some additional investigations into Egypt and the UAE and the lack of comparisons in relevant industries, such as those in the UK or the USA. The respondents of this study were from the UAE, which comprised 71% of the targeted practitioners from the KSA industry; this could have impacted the generalisability of the findings. Due to the limitations of the paper and word limits, a planned real construction case study could not be included in the programme due to time constraints, which will be considered in future work, as explained above.

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