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Article

An Investigation of BIM Advantages in Analyzing Claims Procedures Related to 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 NEOM and the Line project, as well as other new projects as part of the Saudi Vision 2030. Challenges might be limited to shortage of skilled labours, rising costs, construction disputes, and material shortages. This study aims to investigate the claims management procedures under traditional practice to be compared with a proposed BIM package as an alternative solution to mitigate construction disputes. The proposed BIM model improves and streamlines the claims processes through automation. This study presents a prospective and retrospective methods in delays analysis under an accepted program. A questionnaire survey was conducted, and out of a total of 123 practitioners, 79 replied. The findings reveal that 40% of the respondents acknowledged a growing awareness of BIM in the KSA construction industry. 47% agreed that BIM can help reduce potential disputes, and 33% strongly agreed that BIM can reduce overall project cost overruns.

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

1. Introduction

The triangle of time, cost, and quality were the key indicators used to measure project success, 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%) additional time to 70% of construction projects [5]. This emphasizes 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 so long. However, it has been noted that data collection, analysis, and presentation are significant obstacles of how claims are managed. Under traditional methods of claims management, collecting all necessary data and paperwork is an essential process for preparing, presenting, analyzing, and handling the claims [8]. Claims must be supported by evidence, including all required information, adhere to particular 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, particularly those with the most understanding of claims. Consequently, the current dispute and claim resolution processes in the KSA are still lengthy and complicated [10].

The aforementioned problems with traditional management systems require the use of new methods for claims management [11]. Since claimant parties face the risk of losing without an efficient claims management system, it is essential for advanced methods to be interactive, proactive, and capable of handling large volumes of construction information. These methods should dynamically engage with the available information. It is worthwhile to realize that Information and Communication Technologies (ICTs) have improved significantly in recent decades and can be used to improve present management methods [9]. The rapid and inventive improvements in ICTs have significantly impacted the Architecture, Engineering, and Construction (AEC) industry, its management, and information sharing [12]. The link between technology, construction, and legislation is dynamic, with changes in one constantly pushing changes in the others. Building information modelling (BIM) is a technological advancement with various stated benefits in construction management across various projects. In addition to BIM's technological power, interoperability capabilities, early clash detection, integrated procurement, and improved cost management methods, reduced conflict and project team benefits are significant aspects of BIM use [13]. Moreover, BIM is one of the most promising and recent advancements in the construction industry for achieving the industry's long-desired aim of quality through effective project planning and management. Although BIM is not a new concept, it has recently gained much attention, as seen by the growing trend of using BIM in construction projects [14]. Policy measures such as the UK Government Construction 2025 vision to embrace the BIM model for lower construction costs and faster project delivery are key examples of such policies. Furthermore, countries such as Finland, Denmark, and the United States require AEC firms to provide BIM while working on public construction projects [14].

The Kingdom of Saudi Arabia (KSA) has one of the most extensive global construction sectors, with numerous ongoing projects. 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 Kingdom [15]. Hence, now is an opportune time for KSA to align with the sustainable development trend observed in countries like the United States, the United Kingdom, and Australia by embracing (BIM) [16]. Despite a limited amount of documented work, a comprehensive literature review indicates that 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 [17]. Consequently, this paper outlines these aspects, providing a solid foundation for future BIM research within 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 BIM models, as indicated by survey findings [1]. This study aims to present a claims management model utilizing BIM to promote a systematic approach for efficient and streamlined claims processing and more effective claims management practices. This model aims to collect, store, and retrieve comprehensive building data to facilitate design and construction integration and schedule coordination [9]. Moreover, it endeavours to provide a more precise estimation of the claimed time or cost, a realistic assessment of risks, the identification of potential conflicts, and the timely resolution of errors and omissions. To establish a BIM-based claims management model, the researchers selected the claims the model could represent in terms of affected building elements [19,21]. Consequently, the most prevalent construction claims were initially identified. Subsequently, by employing a questionnaire based on an extension of time and money claims for inclusion in the BIM-based claim management model. Storing actual project information and potential claim scenarios in a database and integrating them with the building information model enhanced the feasibility of simulating claims within the building information model [15].

2. Literature Review

2.1. A Review of Claims Management Procedures

The steps of a claim procedure are identified, notified, documented, presented, analyzed through examination, negotiated, and settled, and all these processes require different resources to be engaged and coordinated [5,18]. Identifying a claim in the construction industry requires prompt and precise recognition of an alteration. It is the first and most significant step in alerting the engineer to a potential problem formation. The time constraint is also significant, and the engineer and the company have their respective responsibilities outlined in the contract at this point [19]. 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 [21]. The engineer is provided with these records for review, evaluates and decides the amount of compensation after receiving a formal claim [19]. 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 [19]. Examples of studies in the field of claims management include an expert system framework to aid in the evaluation of claims, a hypertext-based claims analysis system, and a simulation-based approach for claims decisions [5,22]. Decision support systems for delay analysis, an information system for delay management, an agent-based collaborative system for claims resolution, and an automated system known as Clams Managers 2000 for administering construction claims as a process model [23,24]. None of these studies sought to use the visual parameters of building models to link with a central database containing claims-related information for each corresponding model component. Potentially, it might have been used to see the stated parts of a project in context and see how they would have worked together [25]. If this had been possible, it might have aided in the formulation and evaluation of claims by allowing for fast access to and retrieval of relevant information related to each model component [9].

2.2. Claims Management Analysis Under the Traditional Approach

The procedures concerning construction claims in traditional approaches encompass a well-organized 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 [24]. 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. Figure 1 designed in this research to outline a broad overview of the customary steps in construction claims procedures under traditional approaches [15,17]. 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 claim should be based on the established claim procedure, including the determination of causation and the right to claim, accompanied by 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 claim, which necessitates contractual and legal substantiation through the provision of supporting documentation. The duration of the claim formulation and submission is not limited when a bespoke contract is used under the traditional approach, in which the claim should rely upon appropriate tools and resources to expedite the preparation of the claim [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 conventional approaches to analyze claims may not grant the claimant the prerogative to scrutinize and submit the claim thoroughly [21]. This is one of the rationales behind this research endeavour, which aims to investigate the utilization of BIM to evaluate and submit claims, ensuring a more efficient, less time and seamless process.

Unlike the FIDIC contract conditions, the doctrine and Sharia law applicable in the KSA allows 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 [21]. The statutory limitations that result in the forfeiture of rights when raising a claim after a definite time and interest charges due to delayed payments under FIDIC conditions serve as significant obstacles to the full applicability of FIDIC in the KSA industry due to its conflict with Sharia law. In certain instances, contracting parties within the KSA construction industry may customize 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 analyze the construction claim under a traditional approach necessitates a comprehensive undertaking encompassing analysis of delays and cost. The claimant must select the appropriate protocol for analyzing the delay and the relevant indicators for cost analysis. It is important to employ a suitable technique for examining the claim or dispute, as the burden of proof lies with the party seeking to convince the court or arbitration tribunal. Failure to discharge this burden effectively may result in rejecting the claim following a rigorous examination.

2.3. Delays Analysis Related to Extension of Time with Money Claims

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, their corresponding impacts on the accountable party for the delays and the nature of compensation [25]. Delays in construction projects can result in additional costs, prompting parties involved to seek compensation or time extensions to mitigate these effects. Typically, there is a connection between EOT and delay analysis regarding money claims. An extension of time (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 [25]. 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 [28].

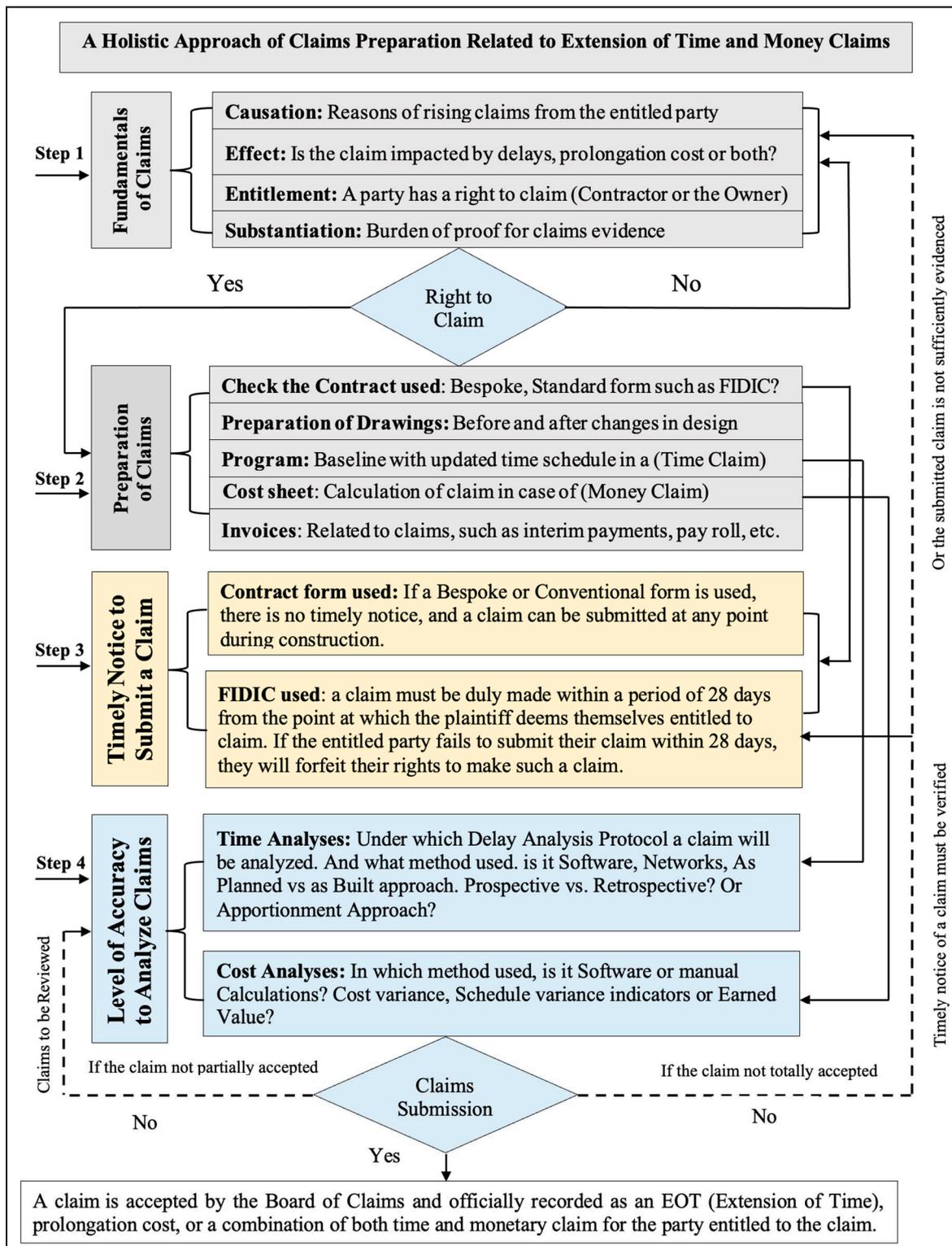


Figure 1. A Flow chart created by the authors to show claims procedures and analysis under a traditional approach.

Concurrent delays in the 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 non-concurrent delays, in which non-concurrent delays are serial independent delays [26]. 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 considered to be 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 [26]. 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.

Analyzing concurrent delays can be a significant challenge and may give rise 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 [27]. The absence of a defined protocol or methodology for analyzing delays in traditional approaches in the construction field in countries such as KSA, Egypt or 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, resulting in additional costs for the contractor [27]. Therefore, the contractor is entitled to receive reimbursement solely on the condition that it can effectively distinguish 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 would have resulted in additional costs, then the contractor will not be eligible to claim reimbursement for those additional costs.

2.4. BIM and Disputes in Construction Projects

When widely adopted, BIM enables a more integrated design and construction process, improving quality and reducing construction projects' unnecessary cost and time [1,27]. There is evidence that BIM adds advantages to the industry despite potential obstacles, such as issues with model ownership, copyright protection, ambiguity over design liability, a lack of contractual standards, model security, and privacy. Governments and construction professionals are attracted to BIM as a remedy to problems in the construction industry due to its advantages [28]. Several BIM tools, such as BIM-Storm, facilitates the development of a design that meets the owner's budget and specifications [14]. BIMStorm enables participants to collaborate via the web and evaluate design alternatives from cost, time, and sustainability perspectives to develop more realistic program requirements. BIM is useful for discovering errors in design and reviewing model updates, and it can generate a report automatically for 3-D object changes between model versions. Most of the abilities attributed to BIM are the facilitation of document management and control [29]. If past experiences are adequately documented, they can be used to predict future disputes and challenges accurately. This is possible through information acquisition, data capture, and knowledge discovery utilizing BIM and additional tools [30].

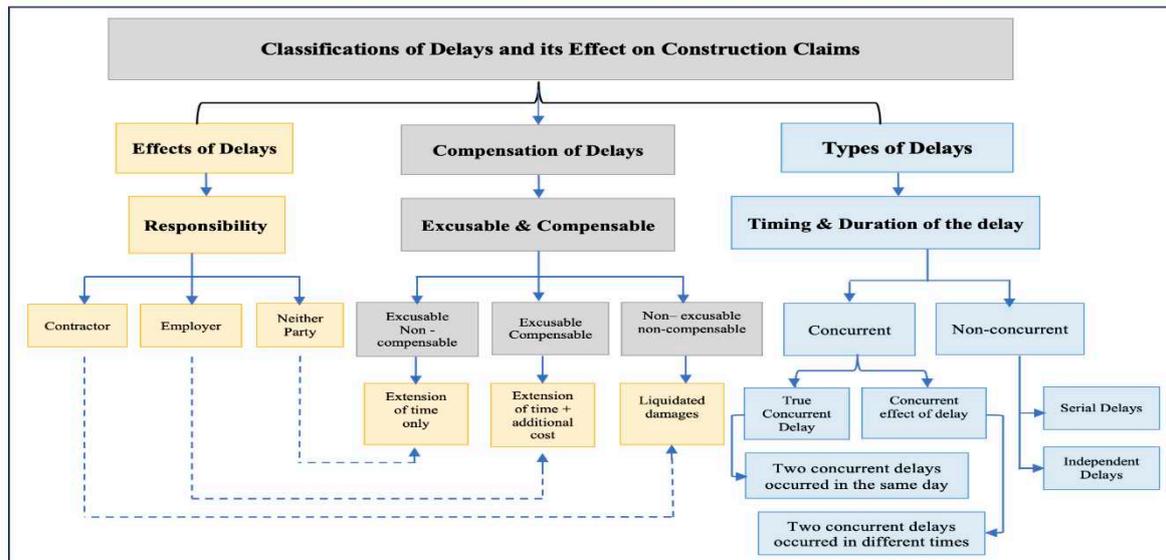


Figure 2. Types and classifications of delays with its effects on the involved parties in construction projects.

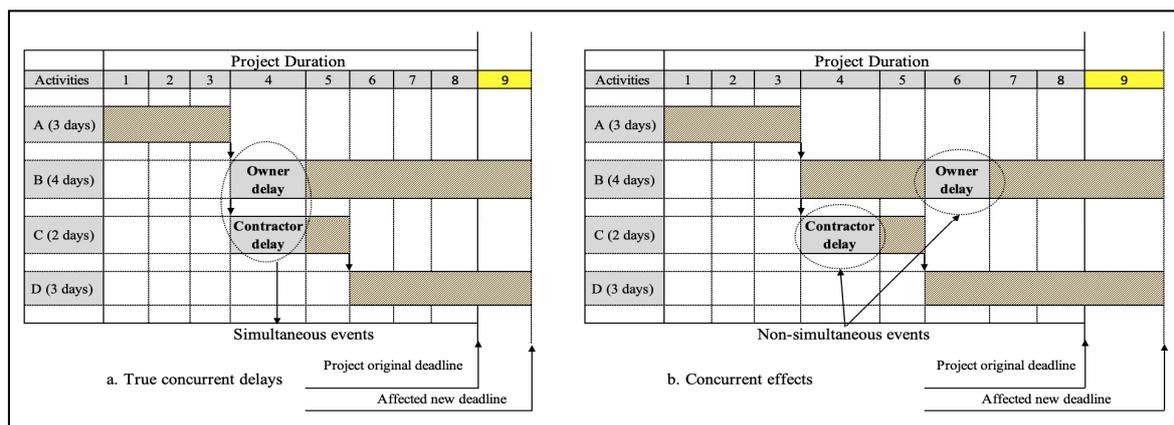


Figure 3. True concurrent delay events versus concurrent effects adopted from [26].

BIM enables comparison between a project's as-planned vs as-built data approach, allowing it to warn about cost, time, and quality discrepancies [31]. 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 [32]. It identifies quality disputes by identifying quality control criteria and responsibility assignments in the construction process through inspection and testing, analysis during the construction phase, and feedback on inspection results [33]. As one of the leading causes of project schedule and budget overruns, construction defects can be identified through BIM-assisted automated inspection utilising augmented reality and image-matching technologies [13,34]. Inadequate safety performance may be improved with the use of BIM, which uses safety rule checking and automatic safety rule simulation to help make construction sites safer and healthier for workers [9,31]. BIM can help construction managers or owners analyse and manage process conflicts and safety issues by supporting dynamic safety analysis of structures and dynamic clash detection of site facilities [35]. Scheduling and space conflicts may be easily analysed with the use of BIM. BIM's mandated collaborative sessions have been demonstrated to boost trust and communication between the parties involved [36]. By its very nature, BIM will lead to 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 team members [37].

When it comes to common data shared, BIM model is built item that aids design, construction, and operation, is a future Information Communication Technology (ICT) resource for responsible decision making [5]. It supports interdisciplinary cooperation, sharing of knowledge, change management, and information support throughout the facility lifecycle in addition to drawing and documentation [38]. Information models can incorporate contracts, specifications, properties, employees, programming, numbers, cost, places, and geometry. BIM makes 3D presentations, stores data digitally, and quickly updates and shares data. BIM helps stakeholders communicate, collaborate on shared project models, and access, coordinate, and share data [5,39]. Project management, construction, engineering, IT, policy, and regulations use BIM knowledge [40]. BIM has transformed the traditional construction industry from a linear and fragmented industry to one in which project stakeholders share common objectives [5,36]. It is believed that BIM can revolutionize the entire Architecture, Engineering, and Construction (AEC) industry by encouraging team collaboration, enhancing project integration, supporting documentation and information flow, supporting facility management, and reducing building costs [41].

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 [17]. The outcome of a claim is heavily dependent on the quality of the claim report [42,43]. Claim evidence can be presented in person, through handwritten documentation, or computer-generated digital data [42]. Utilizing electronic, visual, and demonstrative evidence for construction claims will likely accelerate the construction industry's adoption of BIM [42]. 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 visualization of claims if BIM is implemented on a project from its inception and recommended record-keeping procedures are followed [44]. Visualization is essential for obtaining desired outcomes because, in many claim cases, the work related to a claim case might be invisible onsite and covered by other activities and need to be visualized, especially when the raised claim is later in the construction process [45]. It is predominantly used to enhance communication in architectural design, but its benefits can be realized throughout the entire project life cycle [5]. Consequently, BIM can be adopted as an essential resource for proactively resolving conflicts and claims to avoid disputes [46].

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 the others, where BIM is a significant advancement in this regard [47,48]. The utilisation of BIM technology in the construction industry is subject to various factors and limitations. However, the associated risks of 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 model during the design, construction, and maintenance stages [49]. 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 [47]. To mitigate associated risks, the involved parties in a construction project with the BIM process must sign a single legal agreement laying out their respective technical and legal responsibilities throughout the modelling phase [36,47]. Inexperience with BIM technology in a contractually based model led to issues with the enforceability of specific regulations and agreements with BIM integration within construction projects [50]. Since the construction industry's efforts to reach level 3 BIM by 2016, wherein all parties work together on a single model, this challenge has arisen [51]. 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].

3. A Comparative Analysis of Claims: Prospective vs Retrospective Method with BIM

The preceding sections in the existing relevant literature have delved into and explained the background of claims management under traditional practice. In the realm of traditional practice, the potential resilience of technological advancement may be restricted, or software could be employed in isolation rather than in an integrated manner. In the realm of construction claims analysis with BIM, both prospective and retrospective methods can be practically employed. Figure 4 shows BIM levels with (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. To effectively implement a comprehensive approach using BIM for analyzing 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) [42] and other researchers stated that the assessment of delayed claims poses several challenges, including information retrieval and visualization during the evaluation process [44,52]. A prospective method is an advanced analysis before delays or change orders to predict the likely outcomes of those compensation events. 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 eight days to deliver the new wall, and the installation is expected to take one 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 program. However, it should be noted that this approach relies heavily on theoretical estimates rather than hard facts of claims. The method of delay analysis used for an EOT claim might have significant implications, as it can yield different outcomes. For instance, when a variation order is issued to a contractor, it may result in a delay. By employing a prospective analysis relying on computer-based BIM modelling and Time-Impact Analysis, the contractor may anticipate that the variation will cause a critical delay of 20 days, thus warranting a 20-day EOT claim. However, when evaluating the delay retrospectively, after its complete impact has been felt, it may emerge that the contractor was only delayed by 15 days, as it managed to re-sequence certain activities and mitigate potential delays. Consequently, the contractor's entitlement for either a 15-day or a 20-day EOT becomes evident for the compensation event [53]. The difference can be significant, especially if it determines whether or not liquidated damages for delay need to be paid. The issue becomes more complex and accurate in adjudication, arbitration, or court proceedings where the full impact of events is unknown. The prospective and retrospective methods are analysed in more depth in a series of scenarios based on a construction case in the following sections.

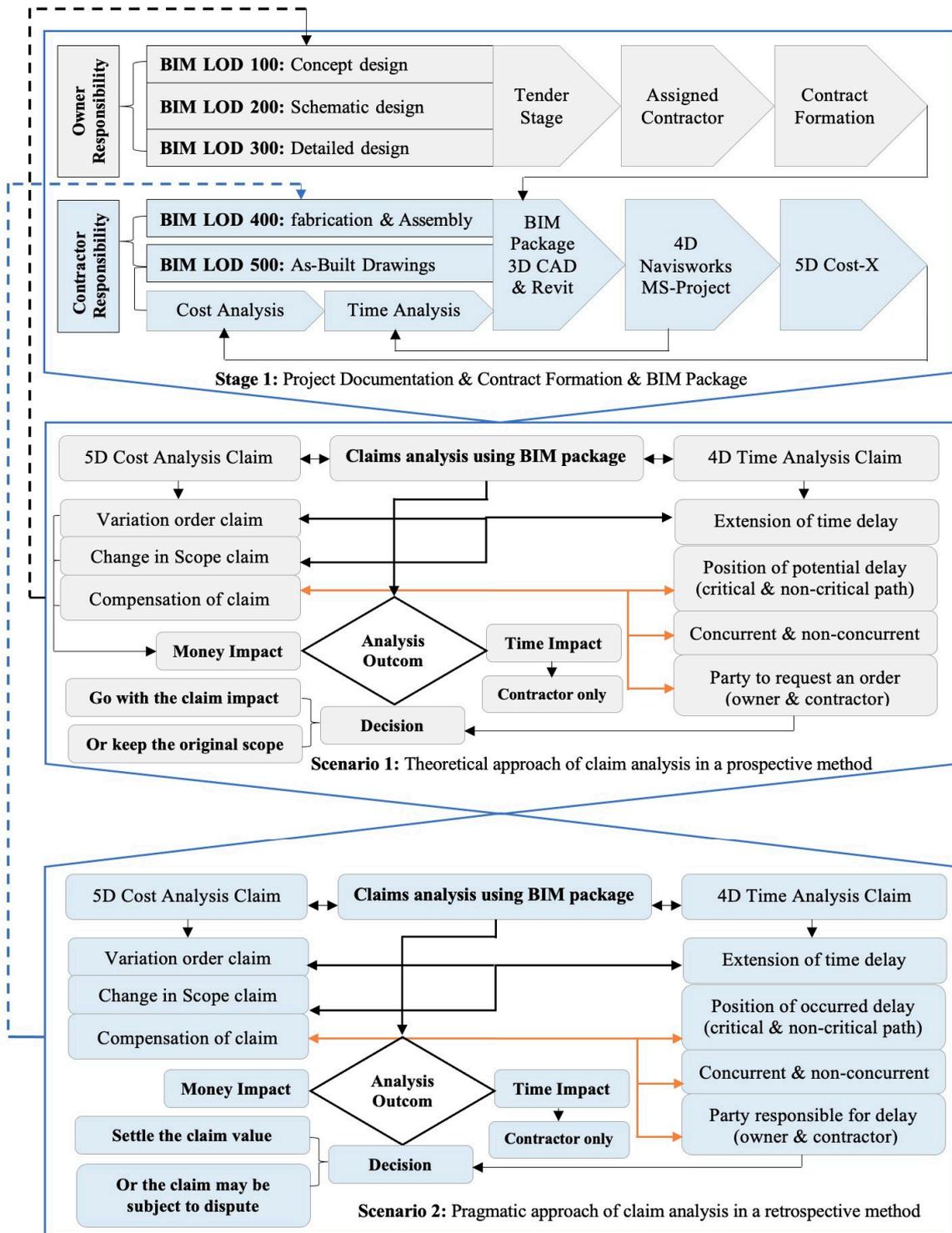


Figure 4. A Flow chart created by the authors to show claims analysis using BIM package under prospective and retrospective methods.

3.1. Simple Program Scenario 1A: As-Built vs As-Planned Program

A simple scenario 1, includes five milestone activities from substructure, superstructure, finishing, MEP, and handing over, expected to be completed by the end of week 15 in the prospective situation, retrospectively. In the scenario 1a in Figure 5, the as-built program compared to the as-planned program, showing a delay of 3 weeks, resulting in completion at the end of week 18 [53]. 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 as plotted on the program at the end of week 6. This event accounts for the delay in starting the finishing activities and the overall delay of 3 weeks in completion. In the prospective analysis, the program starts with the same plan and is updated until just before the compensation event occurs [53]. Figure 5 (1a) indicates that the as-planned program is still scheduled to be completed by the end of week 15, with no delay just before the compensation event.

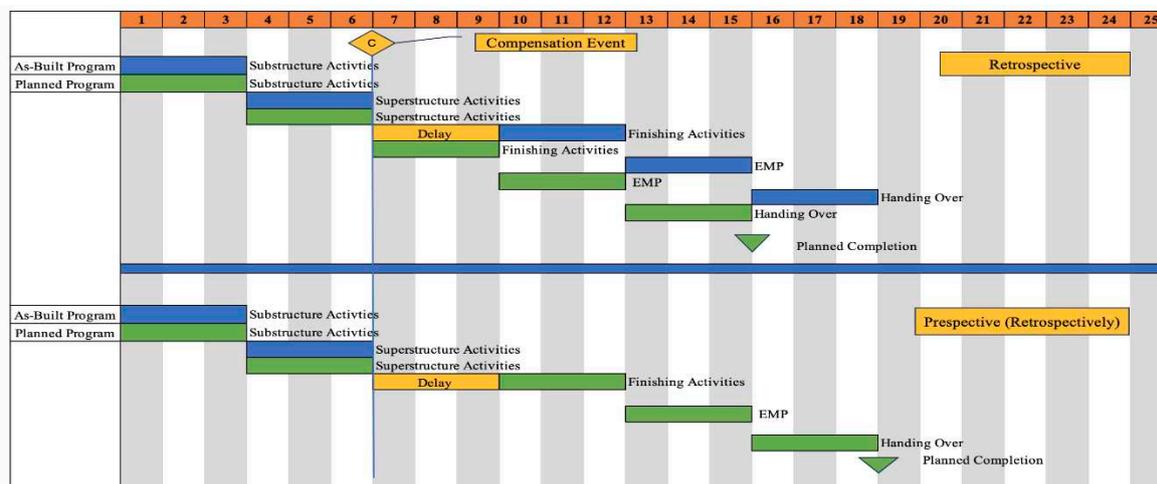


Figure 5. Scenario 1A: Prospective vs Retrospective analysis in the benefit of hindsight, adopted from [53].

3.2. Developed Program Scenario 1B: As-built vs as Planned

With the benefit of hindsight, the first scenario is developed in Figure 6 by considering the impact of the compensation event on the program. The compensation event had 3-week delay, pushing the planned completion date to the end of week 18. This aligns with the completion of the as-built program and demonstrates the same result as a retrospective analysis. However, a prospective analysis carried out contemporaneously, without the benefit of hindsight, would have forecasted a 6-week delay as shown as shown in the scenario (1B) in Figure 6, as it wouldn't know 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 than the as-built program 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].

3.3. Series of the Presented Developed Program as Accepted Programs: As-Planned vs As-Built

To explain both prospective and retrospective analysis in-depth concerning the scenarios mentioned above. Therefore, the first accepted program 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 8. A terminal float of 4 weeks is assumed to represent the period between the planned completion and the completion date, which no delays are attributed to either the contractor or the employer. In the second accepted program, compensation event number 1 is presented to have a duration of 6 weeks but only took 3 weeks in the updated program No. 3, as shown in Figure 9. To analyze its effect, the updated program is considered relevant to the time when the second accepted program was created. When program 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 program No1 to week 16 in the updated program No2. 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 prospective and retrospective situations, as indicated in the tables in the top right-hand corner of each chart.

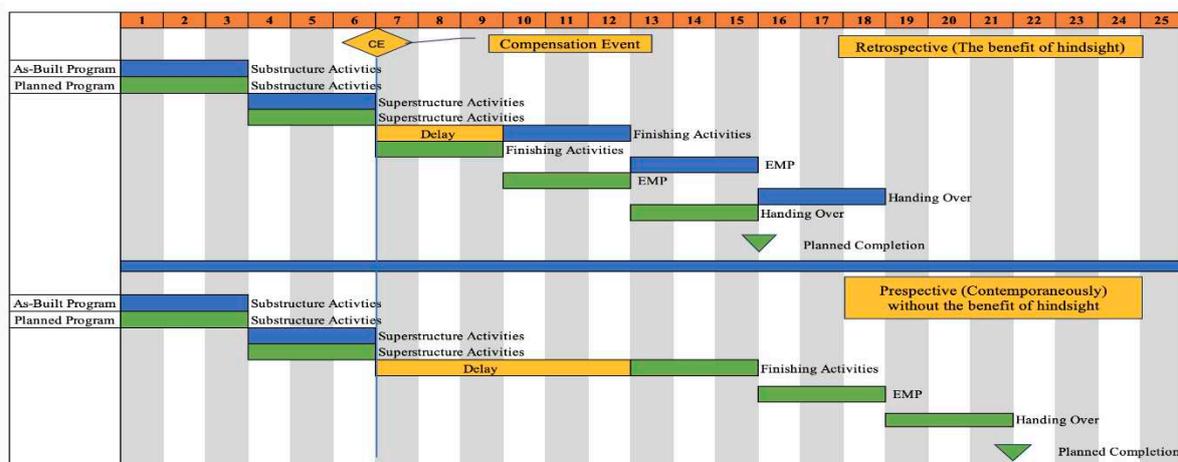


Figure 6. Scenario 1B: Prospective vs Retrospective analysis without the benefit of hindsight, adopted from [53].

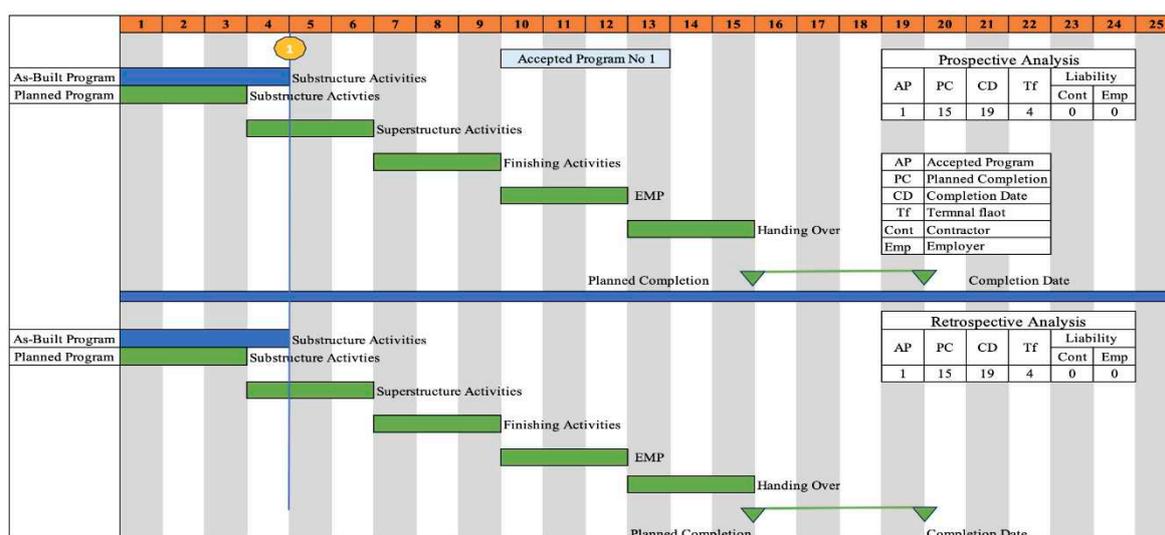


Figure 8. The accepted program No1, adopted from [53].

In the prospective situation, if the approved program No 2 undergoes an update for progress and experiences a delay of 6 weeks that impacts the superstructure activities, it results in 6 weeks extension of the planned completion from week 16 to week 22. Accordingly, the completion date has also been 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 six-week delay lies with the employer since the programs 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 on what happened. When analyzing accepted program No3, shown in Figure 10, the assessment of compensation event number one was incorrect. It only took three weeks to address the event, resulting in a shift of 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 are indicating the three-week delay in the superstructure activities, which pushes the planned completion from week 16 to week 19. Therefore, the completion date will be moved from week 19 to week 22. Hence, in scenario number 3, the employer is accountable for a three-week project

delay, while the terminal float remains at three weeks. In summary, there is a discrepancy in the completion date and the terminal float between the two different analyses.

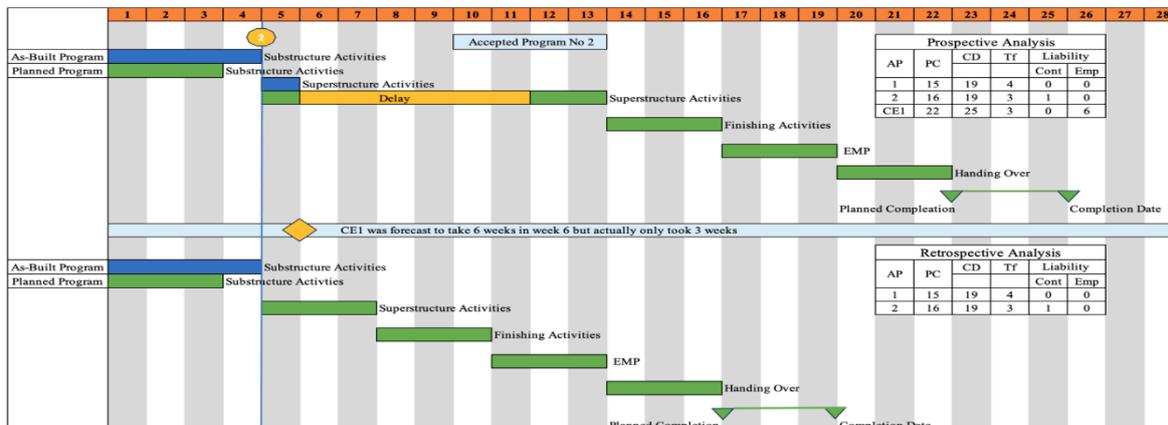


Figure 9. The accepted program No 2, adopted from [53].

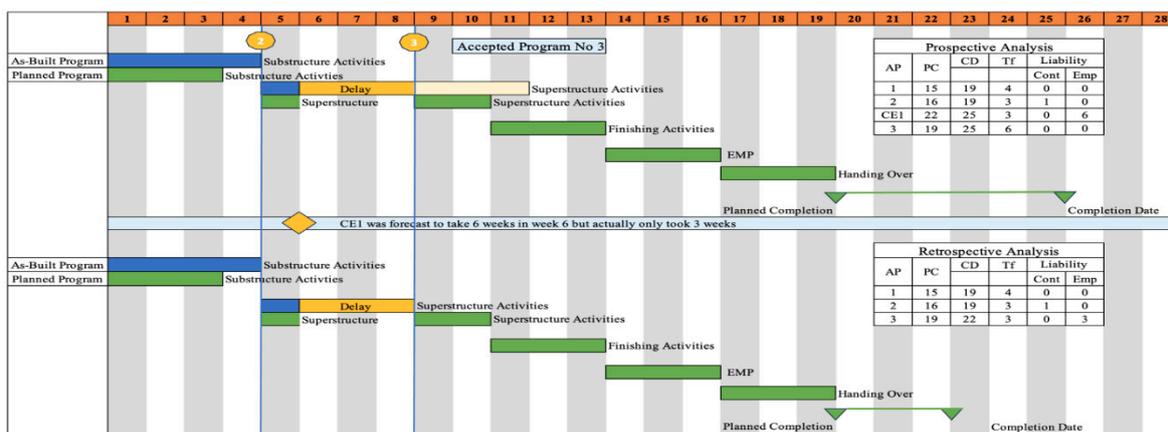


Figure 10. The accepted program No 3, adopted from [53].

In the program No 4, compensation event No2 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 11. To assess its impact on the prospective situation, the accepted program No3 is to be updated, resulting in 4 weeks delay in the superstructure activities. Consequently, the planned completion will be pushed out by 4 weeks, moving from week 19 to week 23. The overall completion date will also shift 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 program 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 six to eight weeks, as the completion date cannot be revised backward in the retrospective situation. We are simply illustrating the two-week delay in the finishing activities, which ultimately pushes the planned completion from week 19 to week 21. The completion date will be moved from week 22 to week 24. The employer is responsible for 2 weeks delay to the project. The terminal float remains at three weeks. In summary, there is a further divergence in the completion date and the terminal float under the two different analyses.

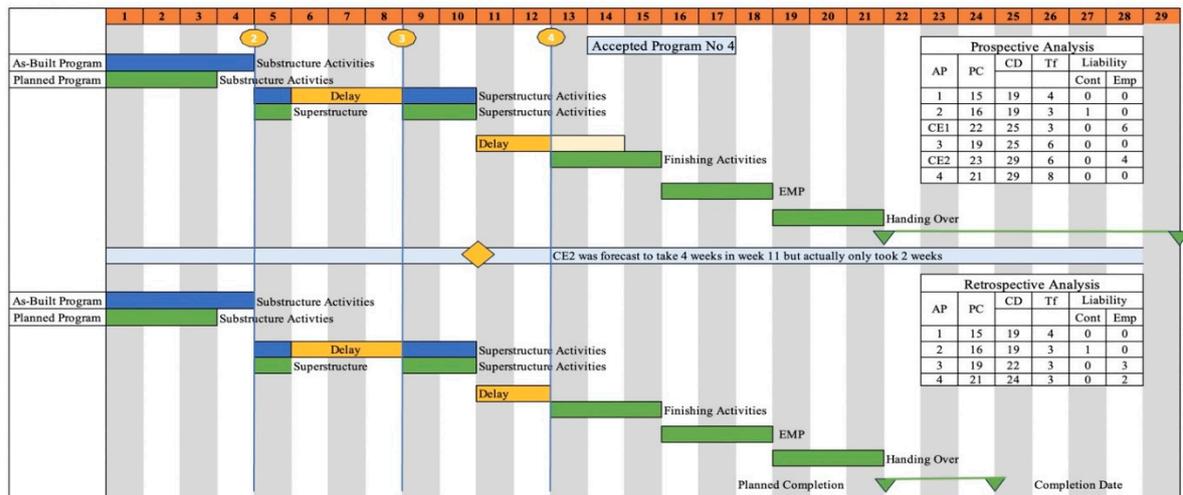


Figure 11. The accepted program No 4, adopted from [53].

In the accepted program No 5 in Figure 12, a compensation event is examined later determined to be under assessed. The compensation event No3 is introduced in week 17, initially assessed to take 2 weeks but took 4 weeks. To analyze its impact in a prospective scenario, we refer to the accepted program at that time, expressly accepted program No5. Notably, there has been 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 program starts to lack clarity. The main purpose of presenting a series of simple programs is to ensure that when a program 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 analysis, the program would be disorganized and dysfunctional. This could result in unreliable assessments of compensation events, particularly when dealing with concurrent effects.

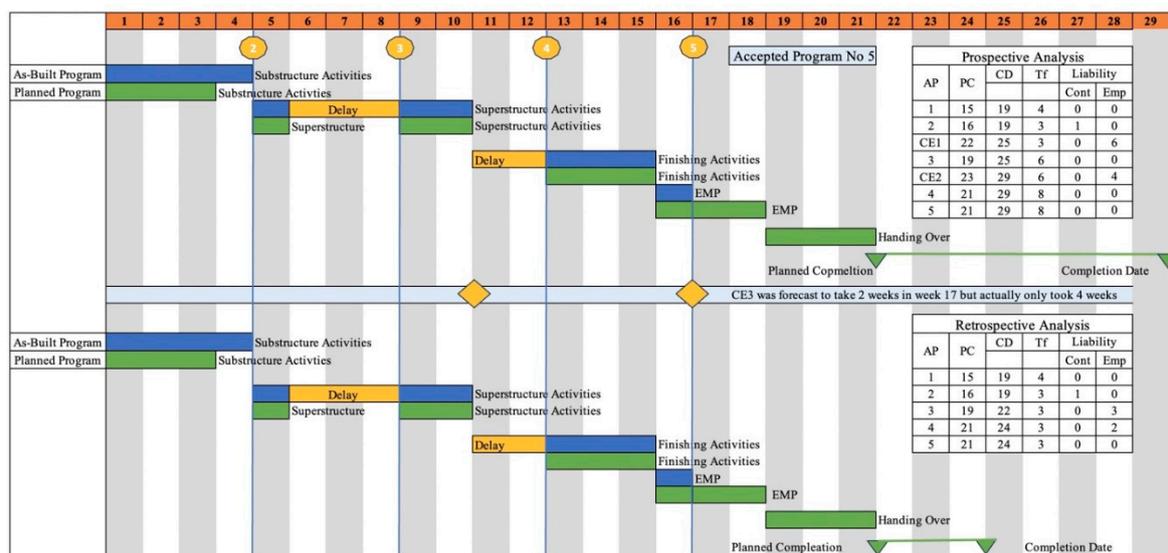


Figure 12. The accepted program No 5, adopted from [53].

4. Research Methodology

The methodology applied in this research is explained in three phases in the subsections below and structured in stages in Figure 13. 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.

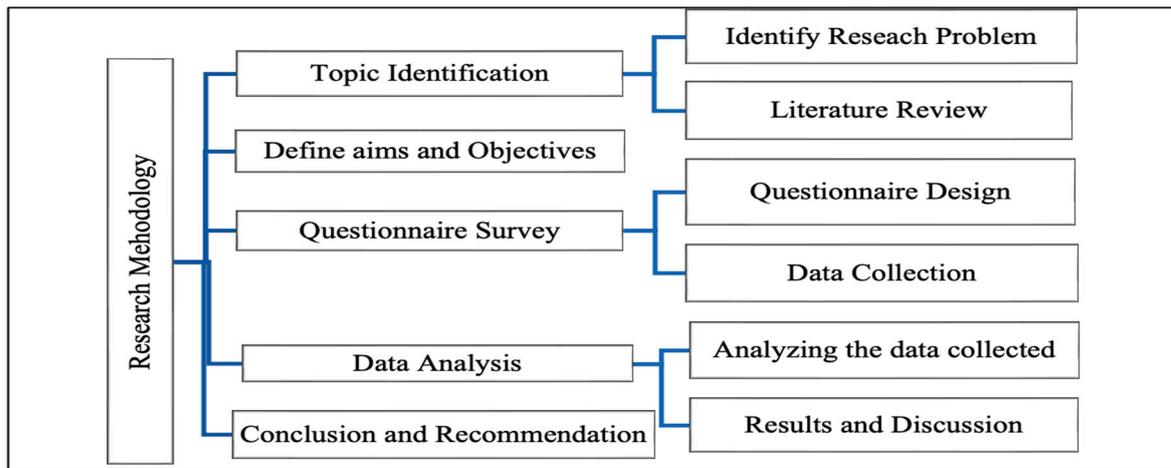


Figure 13. Research methodology.

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

This was achieved by conducting a thorough literature review to provide a comprehensive summary of relevant research that aligns 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 building information modelling (BIM) in Saudi Arabia were critically examined. 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 factors of claims that appeared most frequently were investigated in recent research conducted by the authors of this study [52]. Within that recent study, a compilation of the most commonly reported sources of claims, originating from both contractors and 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 and sent 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 distributed widely in the construction industry in Saudi Arabia, with the scope expanded to include the USA and Egypt to enhance the study's credibility and overcome 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 participants who have at least ten years of experience and more in construction claims management and familiarity with BIM, its tools, and its uses in construction and project management to complete the questionnaire. The targeted audiences ranged from employees of contracting and consulting companies, BIM managers and academics. 56 participants were found to have these requirements in the KSA construction industry as the origin of the study, possibly due to the limitation of BIM use in that field. In addition, another 8 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 good knowledge and experience in BIM technology and a working specialization related to the AEC industry. This includes civil engineers, architects, project managers, BIM managers, and claims managers. Since it is 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, was consulted to provide an accurate number for the required research population. They discovered approximately 234,738 engineers registered with the Saudi Council of Engineers, making them the primary workforce in the construction industry of KSA. To rationalize the actual population, therefore, only 200,000 from the total population is taken to support this study as the statistical calculation with the supported formulas numbers 1 and 2 as shown below.

Formula 1: Cochran Formula

$$n = \frac{z^2 * p * q}{c^2} \quad (1)$$

Z= Z value, taken as 1.96 for 95% confidence level
 P= Percentage 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.
 n= Sample size.

$$\text{Applying the formula: } n = \frac{1.96^2 * 0.5 * (1 - 0.5)}{0.09^2} = 118$$

Formula 2: Slovin's Formula

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

C= margin of error, taken as 9%=0.09
 N= Total population, taken as 200,000.
 n= Sample size.

$$\text{Applying the formula: } n = \frac{\left(\frac{200000}{1}\right) + 200000}{0.09^2} = 123$$

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 are employed due to their ability to enhance 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 are illustrated in categories based on the identified patterns in each section of this study.

5.1. Respondents Profiles

The targeted practitioners were selected based on formula number 2, in which 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 1. The study includes the Likert scale in the questionnaire survey, where qualitative data can be quantified, and open-ended questions can be designed to facilitate statistical analysis of the survey responses. This allows researchers to choose their answers based on whether they strongly agree, agree, or neither agree nor disagree, as shown in Table 2. The open-ended questions are extracted from the questionnaire form based on the Likert scale mechanism, and the results are presented in Figure 14.

Table 1. Participants profile and years of experience.

Position	Organization 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 2. Likert five-point scale used in this questionnaire survey.

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

Table 3: Open-ended questions extracted from the questionnaire survey that distributed in this study

No	Questions	Rate of Answers				
1	How familiar are you with Building Information Modeling (BIM)?	Extremely familiar	Very familiar	Somewhat familiar	Not so familiar	Not at all familiar
		3.57%	35.71%	28.57%	7.14%	25%
2	In your opinion, is there a growing awareness of BIM usage in Saudi Arabia?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
		21.43%	46.43%	28.57%	0%	3.57%
3	Is your organization actively using or planning to use BIM?	Always	Usually	Sometimes	Rarely	Never
		7.14%	28.57%	39.29%	0%	25%
4	In your opinion, using BIM in disputable claims may reduce the degree of recourse to litigation or arbitration?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
		14.29%	46.43%	39.29%	0%	0%
5	In your opinion, will BIM implementation reduce the overall project costs?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
		28.57%	39.29%	32.14%	0%	0%
6	In your opinion, is the implementation of BIM suitable for small and medium-sized construction projects?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
		21.43%	39.29%	28.57%	10.71%	0%
7	In your opinion, does using BIM reduce the possibility of a cost overrun and keep the original budget on track?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
		32.14%	39.29%	25%	0%	3.57%
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 analyzed and relied upon for their outcomes?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
		17.86%	50%	28.57%	0%	0%
9	In your opinion, will implementing BIM help improve construction project productivity?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
		32.14%	39.29%	28.57%	0%	0%
10	Is there a growing demand for BIM usage in Saudi Arabia, Egypt, or the United Emirates?	Yes	No	Not sure		
		60.71%	14.29%	25%		

6. Discussion of the Literature Review and Results

The first section of the literature review examines claim management procedures in construction projects. It emphasizes the importance of including a clear claim identification process in the contract conditions between the parties involved. Failure to include a claim identification process in the contract may 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 complex. One of the main reasons for this is the use of different contract forms in the public and private sectors. The local standard form uses in the public sector is heavily tailored from the FIDIC, while the private sector relies on traditional contract forms tailored to each project. However, the reliance on traditional contracts inherent risks and often leads to disputes and conflicts between the parties involved. Claims can be analyzed using the traditional approach, which does not rely on comprehensive software such as BIM packages. 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 might 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 where they deem themselves entitled to the claim (as displayed in Figure 1). Failure to submit a claim under FIDIC within this time frame may result in a significant loss of claim rights. Additionally, if the supporting documents of a claim are unclear, the entitled party may 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 analysis, and cost analysis to improve claims analysis as an alternative method to the traditional approach. Despite minor obstacles of using BIM in the construction industry, specifically in the KSA, it is evident that BIM can collaborate with the involved parties in construction via the web or common data sharing with each other. For example, when a client or project owner requests a change to the contractor's scope under the BIM process, prompt action to update the drawings might 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. Risk is inherent in the construction industry, and no project is risk-free. Therefore, the risk associated with BIM can arise from various factors, such as ownership of project information, responsibilities for BIM levels, and 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. To mitigate this risk, the contracting parties can sign a single agreement for using and sharing BIM, allowing precise identification of each party's liabilities

To enhance understanding of the BIM package and its practical application, the authors have designed Figure 4. This visualization provides comprehensive insight for contract administrators, claims managers, and delay analysts. 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 minimize 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 prospective and retrospective methods for handling expected claims related to extension of times, 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 three weeks instead of six 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 presented four accepted programs to analyze 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 done after the compensation event has already occurred. In this approach, there is no opportunity to minimize 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 six weeks of superstructure activities starting from week 6, with the employer being responsible for 6 weeks delay, as indicated in the table impeded in the diagram. However, the delay was

shortened to three weeks due to acceleration. In Figure 10, a retrospective analysis indicated a delay of three weeks, for which the employer was liable since it couldn't be reduced. Most delays in construction projects in the KSA construction industry are analyzed 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.

To ensure that the findings of this study are applicable to the construction industry in the KSA, as well as 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 and holding positions such as civil engineers, project managers, procurement managers, and contract administrators. The majority are working in contracting companies, while others were from consultancy and business development. When asked about their familiarity with BIM, it was found that 35% were highly familiar, 35% were not familiar at all, and only 4% were considered experts. The practitioners were asked if there is awareness in the KSA construction industry regarding the use of BIM packages. It was found that 22% strongly agreed, 43% agreed, and 3.6% strongly disagreed. Furthermore, the practitioners were questioned about whether their organization already utilizes BIM technology, with 7% stating 'always', 29% saying 'usually', and 25% stating 'never'.

The selected practitioners were asked in the questionnaire survey if the BIM package, defined in Figure 4 of this study, can effectively reduce the cost overrun of construction projects. The results showed that 33% strongly agreed, 40% agreed, and only 4% disagreed. Moreover, BIM was found to have the potential to reduce disputable claims, with 15% strongly agreeing, 47% agreeing, and 40% neither agreeing nor disagreeing. Furthermore, 29% strongly agreed that BIM can reduce the overall project cost; 40% agreed, while others remained unsure. Finally, the practitioners were asked if they recommend incorporating BIM technology into the contract conditions for each project, regardless of whether it is a traditional or standard form of contract. The survey results showed that 18% strongly agreed, 50% agreed, and 29% neither agreed nor disagreed. Additionally, when asked about the feasibility of recommending BIM for small and medium companies, 22% of the respondents strongly agreed, 40% agreed, and 11% disagreed.

The percentages of the respondents vary, and the authors comment on 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 40% 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 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.

6. Conclusions

This study investigated and analyzed the claims management procedures used in construction projects under traditional practice with a suggestion of an automated methodology to be used in solving claims. It highlights the importance of clear claim identification and claims' impact on time and money. Standard forms of contracts such as FIDIC, JCT, and NEC3 offer solutions to settle construction claims in the KSA concerning the complexity of the construction industry. 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 FIDIC, while the private sector uses traditional contract forms tailored to each project, posing in some cases 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 updated drawings quickly, which impacts both the project's schedule and budget. Nonetheless, there are certain risks associated with BIM, including ownership of project information, allocation of BIM levels, and data reliability. To address these 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 to enhance understanding of the BIM package and its practical application. This visualization provides comprehensive insight to contract administrators, claims managers, and delay analysts. In addition, 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. Stages 2 and 3 in Figure 4 present prospective and retrospective methods for handling expected claims related to time extensions, cost increases, or both. The main difference between the prospective and retrospective methods lies in the timing of the analysis. Prospective 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 provides for accelerated time-impact-related delays.

The study presented a theoretical program that updated 4 steps based on a real-life case to analyze delays in various situations, with a focus on concurrent delays and the liability of both the owner and contractor. Retrospective analysis is conducted without hindsight, aiming to accurately determine claim outcomes, especially in complex cases involving concurrent delays. In the construction industry of the KSA, delays are predominantly analyzed 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 resolution for claims-related delays and cost overruns.

To validate this study, a questionnaire was created and shared in the KSA construction industry and neighbouring countries like Egypt and the UAE, in which BIM packages are required to be implemented. 79 of the 123 practitioners who answered formed 71% of the total targeted sample. Experience ranged from 1 to 35 years for these respondents. When the practitioners asked about BIM familiarity, 35% were highly familiar, 35% were not, and 4% were experts. The answers to the growing awareness in the KSA construction industry about BIM were 22% strongly agreed, 43% agreed, and 3.6% strongly disagreed. The practitioners were asked if their companies use BIM technology, with 7% indicating 'always', 29% saying 'usually', and 25% saying 'never'. It might be believed that the costs of BIM involved may be a concern, but the impact of claims in the construction industry is usually 5-7% of the budget, compared to the estimated 3% required to implement BIM [52]. In addition, the absence of BIM technology in contract documents may not motivate or compel the industry to adopt it, as construction is complex and the kingdom strives for innovative, sustainable large-scale projects.

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 in mitigating potential claims [52]. The current study delves deeply into the claim's procedures under traditional methods versus the BIM package. The authors used a theoretical program to develop the BIM package, which serves as an alternative dispute-resolution method. A subsequent future paper is planned to be based on a real-life dispute case study from the industry will be analyzed to show how the BIM package, shown in Figure 4, was simulated to settle a disputable claim.

Limitations of this study: this study focuses on claims processes related to extensions of time and money claims in the construction industry of Saudi Arabia (KSA) specifically, with some additional investigation into Egypt and the UAE and a lack of comparison in relevant industries such as the UK or USA. The respondents of this study comprised 71% of the targeted practitioners from

the KSA industry, which may impact the generalizability of the findings. A planned real construction case study could not be included in the program due to time constraints.

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