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# Mitigating Construction Delays in Iran: An Empirical Evaluation of Building Information Modeling and Integrated Project Delivery

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**Abstract:** Project delays pose a substantial challenge in the construction sector. The primary objective of this research is to discern the root causes of project delays in the construction industry and proffer potential solutions, inclusive of the application of building information modeling (BIM) and integrated project delivery (IPD). The integration of IPD and BIM, predicated upon established blueprints, was explored to streamline cost management processes and investigate the potential incorporation of design information within the framework of building price lists. A comprehensive review of extant literature identified 20 possible causes of delays in Iranian construction projects. This study employed a descriptive research design, analyzing data collected from 90 questionnaires completed by construction experts using the statistical package for the social sciences (SPSS) statistical software. A case study of the Dehloran Azad University building project was undertaken, utilizing Revit software for simulation exercises. Field investigations, coupled with a questionnaire disseminated among construction consultants and contractors, elucidated four primary factors contributing to project delays in Iran: 1) the employer's failure to fulfill financial obligations; 2) disregard for the socio-political-economic conditions; 3) absence of a feasibility study prior to tender participation; and 4) inadequate interdepartmental communication. Successful project execution hinges on active team participation and the value that such teamwork brings. The implementation of the IPD model was found to encourage increased enthusiasm and participation. Given that the most significant source of delays in Iran's construction projects was identified as financial issues, the adoption of BIM/IPD may mitigate delays and risks associated with inaccurate estimates. This approach was also found to be effective in projects that are in mid-stage completion.

**Keywords:** Integrated project delivery; Project delay; Building information modeling; Construction management

## 1 Introduction

Each annum, a significant proportion of Iran's public funds is devoted to construction projects that invariably miss their projected timelines [1, 2]. Project delays often render previously viable technical and economic plans obsolete in the face of changing circumstances [3]. Construction projects act as vital tools for both nations and organizations, facilitating the transformation of strategic visions, goals, and plans into tangible results [4]. The success index of projects is gauged by five criteria: time performance, cost performance, quality performance, HSE performance, and client satisfaction performance [5].

Research indicates that a mere 23 percent of construction projects in Iran were finalized within the scheduled timeframe between 2002 and 2014, leading to substantial cost overruns [6]. An analysis of diverse construction projects in Iran demonstrated an average delay of 5.9 months per year, with an overall cost overrun of 15.4 percent [7]. As per the Statistical Center of Iran, the direct costs of project delays for the Iranian government were estimated at $21 billion between 2002 and 2012 [7]. These findings underscore the pressing issue of delay in Iranian construction projects [6], thus necessitating further research to identify and mitigate the various causes of these delays, which forms the primary motivation for this study.

Traditional project delivery methods, including Lump Sum Design-Bid-Build (LS), Design/Build (DB), Construction Management at-risk (CMC), and Construction Management Advisor (CMa) are frequently utilized [8, 9]. However, these traditional methods often encounter challenges in terms of teams, processes, risk, compensation, reward, communication, technology, and agreements, which can invariably lead to project delays and cost inflations [8].

In response to the challenges and uncertainties associated with traditional delivery methods, scholars and practitioners have proposed the IPD method as a collaborative and resilient delivery system [10]. IPD promotes an organizational approach that encourages collaboration among diverse project stakeholders from the initial phases, maintaining this interconnected environment throughout the project stages [11]. This system offers numerous advantages, including enhanced productivity, improved coordination, reduced duration, and cost efficiency [12].

A growing inclination towards the IPD method is observed among construction firms due to the increasing complexity of global construction projects [9]. However, despite its global uptake, the IPD method remains relatively unknown and underused in Iran. The absence of teamwork and communication among project stakeholders in the Iranian construction industry has been linked to project failures [6, 13]. The implementation of the IPD model could potentially address this issue, enhancing project outcomes by fostering increased enthusiasm and participation. Additionally, BIM has been recognized as a promising technology in the construction industry, providing efficiency, cost savings, and increased productivity [8]. A thorough exploration of the interaction between BIM and IPD compliance is essential to understand their impact on project performance.

The extant literature and industry practices present certain gaps, particularly a lack of comprehensive research integrating IPD and BIM to efficiently identify, reduce, and manage construction project delays. The potential synergies and effectiveness of combining these methodologies warrant further exploration to optimize project planning and execution.

The present study is directed towards four cohesive objectives: Firstly, the identification and ranking of the primary factors contributing to project delays in construction projects. Secondly, the investigation of contractor and consultant perspectives on the main factors leading to project delays. Thirdly, an exploration of the effectiveness of integrating BIM and IPD in reducing project delays. Lastly, the conduct of a financial estimation of projects using the BIM model with a preventive approach to mitigate delays and enhance overall project efficiency. By addressing these objectives, this research aims to provide valuable insights into the causes of delays and propose strategies for their efficient management and reduction in construction projects.

## 2 Literature Review

### 2.1 Project Delays

The phenomenon of delays in construction projects has been the focus of extensive scholarly research for several years. Investigations in this realm have been primarily bifurcated into two thematic areas: The elucidation of delay factors and an examination of their impacts.

In the context of England, a comprehensive investigation was carried out by Olawale and Sun [14], with the objective of delineating factors impeding project progression and suggesting strategies to alleviate time and cost overruns endemic in construction projects. A similar study was undertaken in Egypt by Abd El-Razek et al. [15], which revealed that stakeholder perspectives vary significantly on the factors contributing to project delays.

An integrated approach to understanding the origins and implications of construction delays was adopted in a Malaysian study by Sambasivan and Soon [16]. They identified 28 factors responsible for project delays, highlighting ten as particularly significant, including inadequate planning, ineffective contractor management, limited contractor experience, financial constraints, and communication deficiencies. A study by Ling and Hoi [17] tailored a time performance guide for Singaporean contractors operating in India to address the unique complexities of the regional construction landscape.

Research conducted in the United Arab Emirates by Faridi and El-Sayegh [18] identified three major causes of project delays: 1) slow approval of construction plans, 2) insufficient pre-planning, and 3) protracted decision-making processes. In a Hong Kong-based study, Lo et al. [19] classified 30 delay factors into seven distinct categories pertinent to the employer, design engineer, contractor, human behavior, project characteristics, and external factors.

Iyer and Jha [20] explored the characteristics of project success and failure in India, identifying telltale signs of project failure such as conflicts among project officials, informational deficiencies, lack of cooperation, challenging economic and social conditions, delays in decision-making, intense competition during tendering, and limited time for tender submission.

In Iran, the mean projected duration for project completion is estimated at 8.9 years [1]. Delays can be divided into two categories: authorized delays, which are beyond the contractor's control and are often due to force majeure events, and unauthorized delays, which arise from the contractor's negligence. The former allows for financial compensation, whereas the latter does not. Factors causing delays have been extensively studied and categorized into justifiable and unjustifiable factors by researchers. The former often includes unpredictable natural events, while the latter typically results from structural, managerial, or operational deficiencies [21].

### 2.2 Integrated Project Delivery and Building Information Modeling

IPD, as defined by the American Institute of Architects (AIA), is a construction industry method that underscores the importance of coordination and collaboration among project team members. IPD facilitates the concerted efforts of architects, engineers, owners, and other stakeholders, thereby enabling them to pool their knowledge and experience, and participate actively in all project phases in a coordinated fashion [22, 23]. This approach underscores the importance of collaboration and teamwork, and when implemented, can enhance construction quality, reduce resource waste and costs, accelerate project schedules, and heighten customer satisfaction. A key outcome of employing IPD is an improvement in construction project timelines due to minimized waste through superior planning and shared risks and rewards [24]. The AIA further characterizes IPD as a collaborative team of multidisciplinary design and construction professionals that leverages alternative processes and technologies to successfully complete a project [25].

BIM, on the other hand, involves the creation, management, and digital representation of building information throughout its lifecycle. The transformative power of BIM significantly influences architectural design, engineering, and construction practices. While architects and design engineers are often considered the primary users of BIM, its advantages extend across the construction industry. BIM provides contractors with an unprecedented opportunity to plan their execution methods and tools prior to project commencement. Its virtual simulation capabilities enable the entire project team, including the main contractor, subcontractors, and builders, to collaborate and rehearse the execution sequence and project site management, thereby enhancing project implementation [26].

The adoption of BIM offers a plethora of advantages such as improved coordination, integration, cooperation, and collaboration among construction project stakeholders. It aids in reducing errors, repetitions, and waste, thereby enhancing profitability and cost-efficiency while fulfilling the client's expectations in the most time-efficient manner [27]. BIM functions as a platform that facilitates various operations involved in modeling the complete lifecycle of a building. By making changes and incorporating new design and construction capabilities into drawings, BIM supports a highly integrated design and construction process. When implemented effectively, this integration leads to superior quality constructions at reduced costs and shorter durations [28]. The optimization of 4D BIM can further contribute to cost reduction and overall construction process efficiency [29].

To facilitate the application of IPD principles in a project, the AIA has formulated standardized contracts, outlining the specific tools necessary for project parties. These IPD contracts typically specify the BIM software tools that are essential for identifying the necessary contractors for the project and the tools that the contractors will employ throughout the project duration [30].

The combination of IPD and BIM involves the integration of two distinct concepts. During the operational phase of a building, maintenance and repair activities necessitate corrective and preventive measures [31]. The joint utilization of IPD and BIM can, hence, enhance the lifespan of a building and facilitate its maintenance and repairs. The AIA document on IPD states that while it is possible to achieve IPD without BIM, the use of BIM is recommended for effective collaboration [32].

The integration of BIM and IPD has garnered significant attention in the construction industry due to their potential to improve project outcomes and efficiency. BIM facilitates collaboration and informed decision-making through 3D modeling, leading to cost savings and improved coordination [33]. IPD encourages early involvement of key stakeholders, fostering teamwork and trust, thereby enhancing project performance [34, 35]. Merging BIM and IPD can leverage their strengths, positively impacting project efficiency and reducing delays. However, challenges such as resistance to cultural change and technological barriers exist [36]. Further research is required to foster successful implementation and adoption of BIM and IPD in construction projects, with particular focus on their role in reducing delays.

## 3 Material and Method

### 3.1 Research Design

A comprehensive review of prior research, field investigation of the case study at hand, and interviews with construction experts were conducted to identify 20 key factors that contribute to delays in construction projects. These factors, which constitute the independent variables of this research, were categorized into four groups for ease of understanding: client, consultant, contractor, and management. The conceptual model representing these factors is depicted in Figure 1.

In light of these variables, a descriptive research method was employed. The descriptive approach is a research method that involves the careful observation and precise description of the characteristics, behaviors, and features of a given group, situation, or phenomenon. This method was applied to analyze the 20 identified factors from the perspectives of consultants and contractors, the details of which are elucidated in section 4.

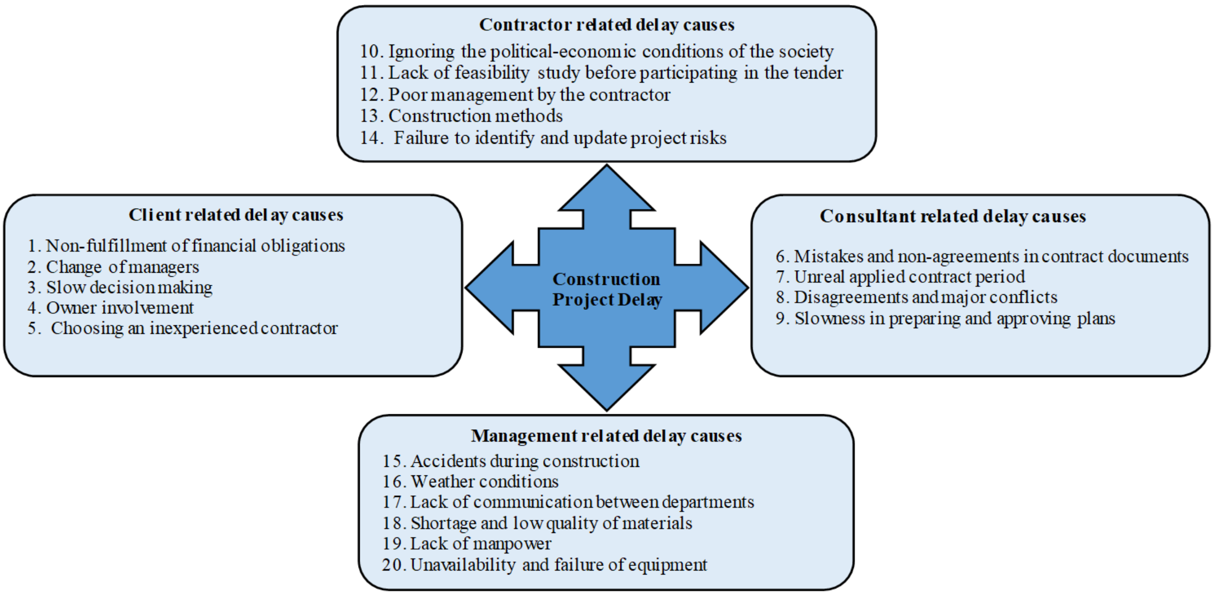


**Figure 1.** Conceptual model

### 3.2 Case Study and Data Collection

The current research focuses on the Dehloran Azad University project, a construction endeavor spanning 788 square meters, initiated in 2011. The project is managed by the Zagros Foundation Company, designated as the contractor following a competitive tendering process conducted by Dehloran Azad University. However, the project has experienced delays attributable to budget limitations resulting from unfavorable national economic conditions, primarily caused by sanctions. These financial difficulties have led to price disparities, causing delays and eventually leading to the project's suspension.

Data collection for this study was carried out in two stages. Firstly, a literature review was conducted, examining articles pertinent to delay factors, IPD, and BIM. Following the initial identification of 20 significant delay factors, a preliminary list was assembled. Subsequently, field data were collected through a survey instrument designed around these 20 identified factors. The questionnaire, developed based on a 5-point Likert scale, solicited the expert opinions of the relevant statistical community on the delay causes. The response options ranged from 'strongly disagree' to 'strongly agree', capturing the level of agreement or disagreement with each factor.

The case study of interest in this research is the building construction project at Dehloran Azad University located in Ilam province. The study's scope was limited due to accessibility constraints; thus, only experts residing in Iran's Ilam province were surveyed. The target population for this study comprised construction experts familiar with the principles of IPD and BIM. By consulting with the engineering system organization and the municipalities of Ilam province, it was estimated that the population size was approximately 120 construction experts/engineers. Based on the Morgan table sampling method, the sample size was determined to be 92. The sampling method employed was non-probability, judgmental sampling, primarily relying on the expertise of the individuals and their availability. Given that contractors and consultants may hold differing views on the causes of delay, the perspectives of both groups were analyzed independently.

Hard copies of the questionnaires were provided to the experts with any necessary explanation or guidance for answering. The process of disseminating and collecting completed questionnaires spanned three months. A response rate of 97.8% was achieved, with 90 completed questionnaires returned.

### 3.3 Data Analysis Method

A total of 92 questionnaires were disseminated among the construction experts, with 47 consultants and 45 contractors participating. The responses were then subjected to statistical analysis using SPSS software.

The Kolmogorov-Smirnov test, executed in SPSS, was employed to assess the normality of variable distributions. The normality test is a statistical procedure that determines whether a given dataset or variable aligns with a normal distribution. In a normal distribution, data surrounds the mean equitably, creating a bell-shaped curve. This assumption of normality is paramount for various statistical analyses, as numerous statistical methods and tests rely on it. The results of the normality test as shown in Table 1 reveal a significance level below 0.05 for the research variables, suggesting a normal distribution for the questionnaire data.

The reliability of the questionnaire was evaluated using Cronbach's alpha coefficient test in SPSS. This metric gauges the internal consistency or reliability of a set of survey items, ensuring that they consistently measure the same construct. The computed reliability coefficient for the data stood at 0.78, exceeding the established threshold of 0.7, thereby confirming the reliability of the questionnaire.

Finally, Revit software, which operates within a BIM environment, was utilized to simulate the financial analysis of the price list.

**Table 1.** Normal distribution of variables

| Components | Kolmogorov Smirnov | .Sig |
|---|---|---|
| Client | 1.762 | 0.004 |
| Consultant | 1.678 | 0.007 |
| Contractor | 1.642 | 0.009 |
| Management | 1.407 | 0.038 |

## 4 Results and Discussion

### 4.1 Delay Analysis

Questionnaires were disseminated amongst a total of 90 construction experts, which included 45 professionals associated with contracting firms and an equal number of experts from the consulting side. The data collected from the responses were subsequently subjected to statistical analysis utilizing SPSS software. All disseminated questionnaires were returned with all queries addressed. The demographic data of the respondents are summarized in Table 2.

**Table 2.** Normal distribution of variables

| Characteristics | Category | Frequency | Percentage (%) |
|---|---|---|---|
| Age | >40 | 47 | 52.22 |
| | 30-40 | 36 | 40.00 |
| | <30 | 7 | 7.78 |
| Specialty | Civil engineering | 46 | 51.11 |
| | Architecture | 38 | 42.22 |
| | Electricity | 3 | 3.33 |
| | Mechanics | 3 | 3.33 |
| Experience | >25 | 21 | 23.33 |
| | 15-25 | 38 | 42.22 |
| | 10-14 | 24 | 26.67 |
| | 5-9 | 7 | 7.78 |
| Education level | PhD | 9 | 10.00 |
| | Master | 32 | 35.56 |
| | Bachelor | 49 | 54.44 |
| Dependency | Contractor | 45 | 50.00 |
| | Consultant | 45 | 50.00 |

The Coefficient of Variation (CV) provides an appropriate measure for comparing the dispersion or variation of two data sets collected using different measurement units. This statistical index calculates the ratio of dispersion to a central criterion, effectively illustrating the magnitude of standard deviation per unit change in the mean. A larger index indicates a greater dispersion of data. In this study, the ranking of delay factors was grounded in the values of the CV. The study outcomes, encompassing the rankings of delay causes, are presented in Table 3 and Table 4. Table 3 offers an insight into the ranking of primary delay causes as perceived by contractors, while Table 4 sheds light on the consultants' perspectives.

Based on the data presented in Table 3 and Table 4, the principal contributors to delays in the construction project of the Dehloran Azad University building were discerned from the viewpoints of both consultants and contractors. The top four factors shared a commonality across both perspectives. The foremost cause pinpointed by both parties was the employer's failure to fulfill financial obligations. Disregarding the socio-political economic conditions was the second factor. The lack of a feasibility study prior to participating in the tender was highlighted in the third position by both groups. The fourth factor, shared by contractors and consultants, was the inadequate communication among the departments involved in the project. These four factors were identified as the primary contributors to the delays experienced in the case study project.

**Table 3.** Prioritizing the main causes of delay (view point of contractors)

| Item | Mean | Standard Deviation | Coefficient of Variation | Rank |
|---|---|---|---|---|
| Non-fulfillment of financial obligations | 4.31 | 0.589 | 0.136 | 1 |
| Ignoring the political-economic conditions of the society | 3.97 | 0.714 | 0.179 | 2 |
| Lack of feasibility study before participating in the tender | 3.86 | 0.858 | 0.221 | 3 |
| Lack of communication between departments | 3.71 | 1.22 | 0.329 | 4 |
| Weather conditions | 3.24 | 1.15 | 0.356 | 5 |
| Mistakes and non-agreements in contract documents | 3.22 | 1.171 | 0.363 | 6 |
| Unreal applied contract period | 3.33 | 1.28 | 0.384 | 7 |
| Shortage and low quality of materials | 3.17 | 1.269 | 0.399 | 8 |
| Poor management by the contractor | 2.84 | 1.17 | 0.412 | 9 |
| Change of managers | 3.46 | 1.45 | 0.419 | 10 |
| Accidents during construction | 3.31 | 1.41 | 0.426 | 11 |
| Lack of manpower | 3.15 | 1.504 | 0.476 | 12 |
| Construction methods | 3.044 | 1.475 | 0.484 | 13 |
| Failure to identify and update project risks | 2.73 | 1.33 | 0.49 | 14 |
| Choosing an inexperienced contractor | 2.75 | 1.368 | 0.496 | 15 |
| Unavailability and failure of equipment | 2.8 | 1.407 | 0.502 | 16 |
| Slow decision making by client | 2.86 | 1.46 | 0.536 | 17 |
| Disagreements and major conflicts | 2.28 | 1.31 | 0.572 | 18 |
| Owner involvement | 2.68 | 1.589 | 0.591 | 19 |
| Slowness in preparing and approving plans | 2.42 | 1.527 | 0.63 | 20 |

It is evident that the primary reason for the project's failure was the lack of consideration for costs and the absence of accurate financial estimation prior to tender participation. To mitigate delays in construction projects, one potential solution is the utilization of the IPD method. This method facilitates rapid project estimation and can help address the challenges associated with project delays.

IPD is a comprehensive implementation system that has recently been recognized for its potential to enhance productivity in projects. Broadly, IPD can significantly mitigate future issues related to delays in semi-real projects. In contrast to traditional methods such as Design-Build (DB), where a definitive cost is determined during the design phase without a detailed feasibility study, IPD provides a more risk-averse approach for the contractor team, thereby reducing costs and other associated risks. In the IPD method, the employer assumes the risk and is actively involved in all stages of design and implementation, which significantly reduces costs. The cost of a project implemented with the IPD method is generally much lower than that executed using traditional methods. The IPD method emphasizes mutual trust, collaboration, and robust communication among project stakeholders. BIM tools are critical for owners to comprehend the objectives and perspectives of the IPD team's designers and builders. When an owner employs IPD for project procurement, BIM can be used by the project team from the design's inception to enhance their understanding of the project requirements and secure cost estimates.

### 4.2 IPD-BIM Modelling

Revit software, known for its comprehensive capabilities in modeling and simulating a variety of architectural and structural components, such as walls, doors, windows, roofs, floors, columns, beams, trusses, and foundations, was employed. Aligned with the primary objective of this research, which is the application of the IPD method to curtail construction project delays, the focus was shifted towards the project segment subjected to the highest frequency of alterations.

In the context of the Dehloran University building project in Iran, a significant portion of the changes was particularly associated with the walls, which were instrumental in contributing to the project's delays. These changes were primarily due to inaccurate estimations during the design phase. Thus, the modeling of walls using Revit software was given special attention. The resulting BIM model of the Dehloran University building project is illustrated in Figure 2.

**Table 4.** Prioritizing the main causes of delay (view point of contractors)

| Item | Mean | Standard Deviation | Coefficient of Variation | Rank |
|---|---|---|---|---|
| Non-fulfillment of financial obligations | 4.17 | 1.14 | 0.273 | 1 |
| Ignoring the political-economic conditions of the society | 3.91 | 1.09 | 0.279 | 2 |
| Lack of feasibility study before participating in the tender | 3.77 | 1.113 | 0.294 | 3 |
| Lack of communication between departments | 3.73 | 1.162 | 0.311 | 4 |
| Lack of manpower | 3.68 | 1.17 | 0.317 | 5 |
| Change of managers | 3.55 | 1.184 | 0.333 | 6 |
| Construction methods | 3.55 | 1.2 | 0.338 | 7 |
| Disagreements and major conflicts | 3.48 | 1.275 | 0.365 | 8 |
| Shortage and low quality of materials | 2.73 | 1.019 | 0.373 | 9 |
| Unavailability and failure of equipment | 3.33 | 1.264 | 0.379 | 10 |
| Accidents during construction | 3.42 | 1.374 | 0.401 | 11 |
| Owner involvement | 3.66 | 1.475 | 0.402 | 12 |
| Failure to identify and update project risks | 3.28 | 1.327 | 0.403 | 13 |
| Poor management by the contractor | 3.37 | 1.37 | 0.405 | 14 |
| Weather conditions | 3.2 | 1.343 | 0.419 | 15 |
| Unreal applied contract period | 3.02 | 1.273 | 0.421 | 16 |
| Slowness in preparing and approving plans | 3.35 | 1.462 | 0.435 | 17 |
| Slow decision making by client | 2.2 | 1.146 | 0.521 | 18 |
| Mistakes and non-agreements in contract documents | 2.64 | 1.44 | 0.547 | 19 |
| Choosing an inexperienced contractor | 3 | 1.77 | 0.592 | 20 |

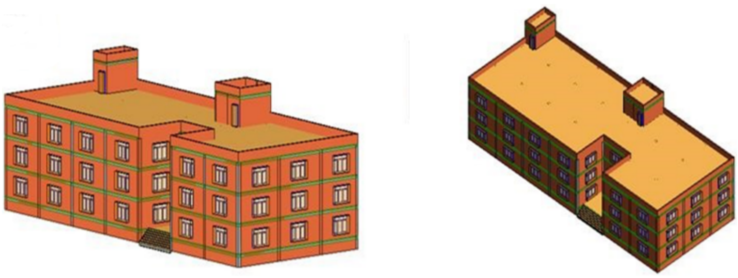

**Figure 2.** BIM model of Dehloran University building project

**Table 5.** Estimated values related to the implementation of the wall

| # | Description of Operation | Unit | Qty | Length | Width | Height | Total |
|---|---|---|---|---|---|---|---|
| 1 | Basement walls with solid bricks | $m^3$ | 1 | 42 | 0.35 | 2.4 | 35.28 |
| 2 | Walling of underground warehouses with solid bricks | $m^3$ | 1 | 19 | 2.4 | 2.4 | 45.6 |
| 3 | External wall brickwork with clay block on the ground floor, 22 cm thickness | $m^3$ | 1 | 22 | 0.22 | 3.2 | 15.49 |
| 4 | Flat brick on the ground floor, 10 cm thickness | $m^3$ | 1 | 31 | 0.1 | 3.2 | 9.92 |
| 5 | External wall brick with clay block in floors, 22 cm thickness | $m^3$ | 4 | 20 | 0.22 | 3 | 52.8 |
| 6 | Flat bricks in the floors, 10 cm thickness | $m^3$ | 4 | 38 | 0.1 | 3 | 45.6 |

Following the identification of the wall component as the most frequently altered, the associated sections in the price list underwent a detailed analysis. Given that the sample walls in the Dehloran Azad University project were constructed of bricks with applied mortar and plaster, the unit prices for brickwork and mortar, brickwork and plastering, as well as plastering and banding were meticulously examined and computed within the price list.

Through the juxtaposition of values presented in Table 5 with the BIM model of the project, a highly accurate financial estimate for the wall can be derived, thus minimizing potential delays arising from calculation inaccuracies.

### 4.3 Discussion

Insights of significant value concerning the principal factors contributing to construction project delays in Iran have been gleaned from this study, as perceived from the perspectives of both contractors and consultants. The recognition of these key delay factors serves to augment understanding of the challenges inherent within Iran's construction industry. The implications of these findings hold potential to inform future project management strategies and decision-making processes, thus enabling stakeholders to effectively prioritize and address critical delay factors. Furthermore, the study underscores the importance of the integration of IPD and BIM methodologies, which have been shown to enhance project efficiency and mitigate delays.

The findings from this research have potential applicability to other analogous construction projects in Iran, as well as in regions grappling with similar economic challenges and sanctions. The delay factors identified, along with the importance of integrating IPD and BIM methodologies, hold relevance and can offer valuable insights to project stakeholders looking to mitigate delays and boost project efficiency.

However, the study's primary limitation lies in its focus on a singular case study, namely the Dehloran Azad University project. The resulting findings may not fully encompass the intricacies and variations inherent in other projects, as each project possesses unique characteristics and contextual aspects. Therefore, caution is advised when seeking to directly apply these results to different projects. Further investigation encompassing a broader range of projects is recommended to corroborate the general applicability of the findings.

Within this study, the key features of the utilized IPD model are early involvement of principal stakeholders, mutual accountability, shared risks and rewards, continuous collaboration and communication, and a focus on project efficiency. The research also accentuates the use of integrated technology, such as BIM, to enhance visualization and coordination among stakeholders. In addition, the IPD model's emphasis on early planning and design to address potential challenges and optimize project outcomes is underscored in this research. Collectively, these attributes of the IPD model contribute to reducing construction project delays and improving project outcomes.

## 5 Conclusions

This research endeavored to enhance the project execution process by harnessing IPD to mitigate delays. The investigation probed the functionalities of IPD and BIM systems, with particular focus on their combined application in alleviating project delays. The Dehloran University building project in Ilam, Iran, served as a practical case study, elucidating the challenges encountered due to financial discussions and inadequate estimation and feasibility studies. The 20 delay causes discerned through the literature review were categorized into four groups, namely client, consultant, contractor, and management, for improved comprehension. An analysis of these significant delay factors from the perspectives of contractors and consultants yielded invaluable insights into the primary causes of construction project delays in Iran. The research identified four principal causes of construction delays:

1) non-fulfillment of financial obligations by the employer;
2) disregard for the socio-political economic conditions;
3) absence of feasibility study before tender participation;
4) lack of interdepartmental communication.

The incorporation of BIM and REVIT software in the project facilitated simulations and cost estimations, showcasing the potential advantages of technology integration in the construction industry. Through this amalgamation, the project team was able to promptly update design modifications and associated cost variations based on specific contract types, utilizing the price list. The findings emphasized the crucial role of IPD in fostering collaboration and trust among project stakeholders, leading to improved project management.

Nonetheless, the study also identified certain limitations, most notably the paucity of individuals with comprehensive knowledge regarding building information modeling, which may have influenced the depth of exploration in this domain. This limitation indicates the necessity for further research to bridge the knowledge gap and fully investigate the potential of BIM in construction projects.

Considering the implications of the research, it becomes evident that the adoption of IPD and BIM in the construction industry carries significant potential in reducing delays and enhancing project outcomes. The findings contribute not only to a deeper understanding of delay factors but also highlight the value of technology integration in streamlining project management processes. Future research could build upon these insights by examining the long-term impacts of adopting IPD and BIM across different construction projects and industries. Additionally, investigating strategies to overcome barriers to the widespread adoption of these methodologies could further enhance their effectiveness in mitigating delays and improving project delivery. By addressing these broader implications and the study's limitations, the construction industry can progress towards more efficient and successful project implementation.

### Author Contributions

Methodology, G.M. and Y.Z.; supervision, G.M.; data analysis, Y.Z.; writing—original draft preparation, Z.D. All the authors contributed to writing the article, read and approved its submission.

### Data Availability

The data used to support the research findings are available from the corresponding author upon request.

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### Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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