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A BIM-IPD Integrated Framework for Reducing Disputes in Construction Projects in Egypt

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Abstract

Disputes remain a persistent challenge in Egyptian construction projects, due to traditional procurement approaches that hinder effective communication, coordination, and collaboration. As Egypt continues investing in mega construction projects, these issues are exacerbated despite the adoption of various management strategies. This study explores how incorporating Integrated Project Delivery (IPD) and Building Information Modelling (BIM) can enhance collaboration, transparency, and project coordination to mitigate disputes. A mixed-methods research approach incorporating literature review, case studies, and a survey of large contractors in Egypt was employed to assess dispute causes, their impacts, and the role of IPD and BIM in reducing disputes. Findings indicate that time extensions and work delays are the primary dispute triggers, leading to project delays and cost overruns. Although BIM awareness is high (85%), only 48% of respondents are familiar with IPD, yet 94% recognise BIM's role in supporting IPD, and 95% emphasise the need for an integrated framework. Case studies demonstrated that IPD significantly improves project performance and reduces disputes compared to traditional procurement methods, though design-bid-build remains the dominant contract type. The study also identifies significant organisational and legal challenges in implementing IPD and BIM, with a strong correlation between the two, while technological and legal challenges show a weaker connection. In response, a novel framework was developed to integrate BIM and IPD, addressing dispute causes and implementation barriers. This framework provides a structured approach outlining essential activities, tools, techniques, involved personnel, required resources, and implementation strategies, presenting an original synthesis that received limited attention in construction literature.

1. Introduction

Effective communication and coordination are essential for the successful delivery of construction projects. Clear and frequent communication among project teams and stakeholders ensures alignment with goals, timelines, and requirements, reducing risks of delays and cost overruns [1]. Coordination facilitates the sequential and efficient execution of activities, optimising resources, minimising conflicts, and maintaining project schedules. Together, these practices foster a collaborative work environment, leading to enhanced project outcomes, improved quality, greater efficiency, and higher client satisfaction [2]. However, disputes remain an inherent challenge in construction projects, particularly in Egypt, where traditional procurement approaches and contracts exacerbate issues. These methods, characterised by a separation of design and construction processes, stringent timelines, and complex stakeholder interactions, contribute to causes of disputes such as poor communication, scope changes, work progress delays, payment delays, design errors, and contract ambiguities [3]. Despite the development of various strategies like Total Quality Management, robust design, reliability analysis, quality function deployment and concurrent engineering [4], disputes persist due to the inherent limitations of traditional processes. These unresolved disputes often lead to project delays, cost overruns, reduced productivity, and strained relationships among project participants. IPD presents a promising alternative by integrating people, systems, business structures, and practices into a collaborative process. This approach optimises project results, reduces conflicts and disputes, and addresses the inefficiencies of traditional procurement methods by maximising efficiency across all project phases [5&6]. In addition, BIM is a powerful tool that complements the IPD framework, enhancing communication and coordination while mitigating disputes among project participants. Together, IPD and BIM can address the recurring challenges in the construction sector [7&8]. Currently, the Egyptian government is expanding its investments in new mega construction projects and infrastructure facilities like the new administrative capital, bridges, roads, and energy projects, which have amplified disputes among stakeholders [9]. This paper aims to develop a framework integrating BIM and IPD to reduce disputes in Egyptian construction projects by addressing traditional process limitations, fostering collaboration, and leveraging technology to achieve higher efficiency and project success. In pursuit of this goal, a research strategy was devised to fulfil four specific objectives. Firstly, establishing a comprehensive theoretical framework by conducting an in-depth examination of pertinent aspects of the research, including the nature of the construction industry, building procurement, disputes, IPD and BIM. Subsequently, the research presented and analysed 4 case studies of construction projects to scrutinise the role of IPD in resolving project disputes and the consequences of its absence. Thirdly, the research intended to explore the perceptions of ADFs operating in Egypt concerning the causes, impacts and role of IPD and BIM in reducing disputes in construction projects and implementing challenges. Finally, the research developed a comprehensive framework integrating BIM and IPD to reduce disputes in construction projects in Egypt.

2. Literature Review

2.1 Nature of the Construction Industry

The construction industry is a dynamic and multifaceted sector that plays a vital economic role, involving activities such as planning, design, procurement, construction, and post-construction services for both public and private projects [10]. Its complexity arises from the involvement of diverse stakeholders with varying objectives, the uniqueness of each project, strict deadlines, significant financial demands, and the need to comply with extensive regulations. Factors like weather and evolving technology add further challenges, often leading to disputes over contracts, payments, delays, quality, and scope changes. Addressing these issues requires clear communication, effective planning, and proactive dispute management strategies [11&12].

2.2 Disputes

2.2.1 Definition and Background

A dispute arises from conflicting views between project parties, defined as a disagreement over facts, law, or policy where one party's claim is denied or countered by another. While often used interchangeably, disputes and conflicts differ. Conflicts involve disagreements that, if unresolved, escalate into disputes. Disputes are typically addressed through formal or informal resolution methods, including arbitration or litigation. The resolution process becomes costlier and more time-consuming as disputes escalate. Proactively managing conflicts can prevent disputes and reduce the need for legal intervention [13].

2.2.2 Causes and Impacts of Disputes

Disputes in construction projects stem from traditional procurement methods, fragmented organisational structure, adversarial contractual frameworks, and the actions or omissions of clients, architects, designers, contractors, suppliers, and regulatory authorities, leading to a range of impacts. The organisational theory identifies these conditions as symptoms of poor coordination, weak information flows, and unclear role boundaries. The identification of causes and impacts of disputes in construction projects was derived from an extensive review of previous research studies, which systematically analysed and ranked these causes and impacts based on their significance and influence on project outcomes. These studies highlighted the most critical factors that consistently contribute to disputes across various construction projects and contexts. By selecting the top-ranked causes and impacts, this research ensures a focus on the most impactful and recurrent issues. This approach provides a solid foundation for understanding the root causes and impacts of disputes in construction projects, see Table 1 which summarises dispute causes, contributors and impacts.

Table 1 *Causes, contributors and impacts of disputes in construction projects (developed by the authors)*

No.	Cause of Disputes (CDs)	Reference	Contributors						Impacts			
			Client	Architect	Designers	Contractor	supplier	Regulatory authorities	Project delay (ID 1)	Cost overrun (ID 2)	Loss of project quality (ID 3)	Loss of long-term working relationship (ID 4)
CD (1)	Time extensions and the contractor's inability to meet deadlines	[14,15]				X			X	X		
CD (2)	Operational delays in work progress		X			X	X	X	X	X		
CD (3)	Delayed or non-payment to contractors	[14-16]	X						X	X		X
CD (4)	Changes in project scope	[14,17,18]	X	X					X	X	X	
CD (5)	Inadequate or incomplete technical specifications	[17,19,20]		X	X				X	X	X	
CD (6)	Poor design quality, inaccuracies, and oversights.	[21-23]		X	X				X	X	X	
CD (7)	Different interpretations of contract provisions and non-compliance	[3,17,24-26]	X	X	X	X			X	X		X
CD (8)	Ambiguous or contradictory contract clauses		X	X	X				X	X		X
CD (9)	Lack of effective communication	[1,14,23,27,28]	X	X	X	X	X	X	X	X	X	X
CD (10)	Limited availability of critical project information		X	X	X	X	X	X	X	X	X	
CD (11)	Absence of team spirit and collaboration		X	X	X	X	X		X	X		X

2.3 Building Procurement

Building procurement refers to the structured process through which construction projects are initiated, developed, and completed. It encompasses the contractual frameworks that enable clients to engage various stakeholders, ensuring that a built facility is designed, constructed, and delivered for use. This process is critical for project success and involves multiple procurement methods [29]. Traditionally, procurement selection focused on the lowest-priced bid; however, recent trends have shifted the emphasis toward achieving the best value [30]. When a client seeks to construct a new building, renovate, or extend an existing one, they typically engage various construction-related organisations to realise the desired outcome. The construction industry employs two primary procurement methods: traditional and non-traditional approaches [31] [32].

2.3.1 Traditional Methods

Traditional procurement methods in construction continue to be widely used, despite their limitations. These methods create a clear division between design and construction, leading to limited collaboration and communication. The process is sequential, often resulting in delays, cost overruns, disputes, and quality issues due to rework and poor planning. The adversarial relationships between designers and contractors, as well as the reliance on single-stage competitive tendering, further hinder cooperation and can lead to suboptimal outcomes and disputes [31]. These challenges significantly impact project delivery, particularly in terms of time and cost, with inadequate planning, poor communication, and a lack of skilled personnel contributing to poor performance. While traditional procurement remains the standard, there is increasing awareness of its shortcomings. This has led to discussions about alternative methods that emphasise collaboration, efficiency, and improved project outcomes by better aligning stakeholders and enhancing project execution [33]. The types of contracts commonly used in traditional procurement include fixed-price contracts, unit price contracts, cost reimbursement contracts, and cost-target contracts [34].

2.3.2 Non-traditional Methods

Non-traditional procurement in construction includes innovative approaches that differ from conventional methods, with the goal of improving project delivery and fostering collaboration. These methods are gaining recognition for their ability to strengthen relationships among stakeholders, optimise resource allocation, and address challenges such as disputes. Key features of non-traditional procurement include promoting collaborative relationships, emphasizing the importance of effective communication for improved performance and stakeholder engagement [31]. Additionally, innovative financing approaches, such as rolling advance payments and direct financing, help resolve cash flow problems, benefiting all parties involved [35]. Modern methods of construction are also part of this shift, offering rapid delivery and sustainable solutions to address issues like housing shortages and climate change, although their adoption is slow due to concerns over building performance and regulatory compliance [36]. While non-traditional procurement offers many advantages, its successful implementation requires overcoming cultural resistance and securing stakeholder buy-in, which are essential for realising its full potential in the construction industry. Types of contracts that are usually used under the non-traditional procurement include Design and Build contract, management-based contracts and partnering contracts [34].

2.4 IPD

2.4.1 Definition and Background

IPD is a collaborative project delivery method designed for large-scale projects, aiming to improve efficiency, reduce costs, minimise waste, and reduce disputes. It involves a formal alliance of project stakeholders who work together throughout the entire project lifecycle. According to the American Institute of Architects (AIA), IPD integrates people, systems, and practices to optimise project results, increase value for the owner, and maximize efficiency across all phases of design, fabrication, and construction [5]. IPD requires all project team members to sign a shared agreement that includes mutual risks and rewards. Early contributions and the adoption of innovative processes are key to achieving reduced costs, faster construction times, and less waste. IPD has emerged as a result of three major advancements in the construction industry: BIM, lean construction practices, and sustainability. BIM supports more collaborative project delivery, lean construction focuses on enhancing delivered values while reducing waste [37], and finally, delivering early contractor and supplier involvement is crucial for meeting sustainability goals [38]. This approach is seen as a significant evolution in collaborative contracting, promising to enhance the construction process through more integrated teamwork and advanced technologies [39] [40].

2.4.2 IPD Characteristics

In IPD, all project stakeholders are involved early in the process to align on project goals and establish cost targets. This approach includes a Guaranteed Maximum Price agreement and a risk-sharing incentive pool. Savings increase profits for all, while losses are shared. If the pool is depleted, the client covers additional costs [40] [41]

[42]. IPD shifts traditional processes to earlier stages, emphasising detailed planning and accurate execution [5]. Despite no universal standard for IPD, key characteristics consistently define its application:

i. Early involvement of key participants (EIKP)
ii. Shared risk and reward (SRR)
iii. Multi-Party contract (MPC)
iv. Collaborative decision-making and control (CDMC)
v. Liability waivers among key participants (LWKP)
vi. Jointly developed and validated goals (JDVG) [41-43].

2.4.3 IPD Advantages and Challenges

IPD strengthens collaboration, aligns incentives, and integrates BIM to enhance Value for Money for building owners. Grounded in collaborative contracting theory, IPD restructures traditional adversarial contracting by promoting shared risks, shared rewards, and joint decision-making, thereby fostering trust-based alliances [44]. Empirical evidence shows that IPD can reduce costs by 2–10% on individual projects and up to 30% across multiple projects through early team involvement, improved communication, and streamlined design–construction workflows. Practices such as the “Big Room,” value engineering, and continuous improvement further support sustainability, quality enhancement, waste reduction, and innovation [45–47]. Despite these advantages, several adoption barriers persist. Decision-making complexity and client hesitancy toward multi-party contracts limit implementation, while cultural resistance remains significant in industries accustomed to fragmented working methods [40]. Legal and financial constraints—including procurement systems that separate design from construction and traditional risk allocation models—further hinder progress [39]. Organisational challenges arise from the need for new processes, communication approaches, and cultural adjustments, which may face internal resistance. Technological barriers include uneven IT capabilities, interoperability issues, and inconsistent information management protocols across project partners [40–43]. Othman and Youssef [6] identified 30 IPD implementation challenges across five categories: integration; cooperation, commitment, and trust; knowledge, experience, and decision-making; cultural; legal and contractual; and technical and financial. Overall, while IPD offers substantial performance and value benefits, its successful adoption depends on overcoming interconnected legal, organisational, cultural, and technological constraints.

2.4.4 IPD Contract Form

AIA provides standardised contracts to support IPD implementation. They are categorized into three levels. The Transitional Form (AIA Documents A195-2008, B195-2008, and A295-2008) is used after appointing a construction manager and maintains traditional role separation, allowing IPD implementation without risk-sharing. The Multi-Party Agreement consolidates the owner, architect, and contractor under a single contract, fostering collaboration and alignment toward shared goals, leading to higher project quality and additional intangible benefits. The Single-Purpose Entity (SPE) model establishes a Limited Liability Company (LLC) comprising the owner, architect, construction manager, and key stakeholders, exclusively dedicated to project design and construction, with the flexibility to engage subcontractors and consultants under separate agreements [48].

2.5 BIM

2.5.1 Definition and Background

BIM is a relatively new technology in the construction industry. It is a digital representation of a project, BIM integrates precise geometry and relevant data essential for construction, fabrication, and procurement. Dossick and Neff [49] highlighted that BIM clarifies the interconnected nature of structure, architecture, and mechanical, electrical, and plumbing systems by linking project participants through technology. BIM encompasses a range of software tools used by construction and design professionals to plan, design, analyse, and develop various components of a building [39].

2.5.2 BIM Characteristics

BIM offers several key characteristics that enhance the efficiency and effectiveness of construction projects. First, its 3D visualisation feature provides a detailed and accurate representation of the building, allowing stakeholders to better understand the design and detect potential issues early. BIM integrates all relevant project data, such as geometry, materials, cost estimates, and schedules, into a single model, ensuring consistency and improving communication among teams. The collaborative nature of BIM allows architects, engineers, contractors, and owners to work on a shared model, reducing miscommunication and enhancing coordination [7&50]. BIM supports the entire lifecycle of a project, from design to operation, making it a valuable tool for facility management and future renovations. The ability to perform clash detection ensures that conflicts between different systems, like structural and MEP elements, are identified and resolved before construction begins, preventing costly delays and disputes. Additionally, BIM enables data-driven decision-making, helping project managers optimise costs, schedules, and resources based on accurate, real-time information. Its simulation and analysis capabilities allow for the testing of different scenarios, such as energy performance or structural integrity, improving the building's overall design and efficiency. Lastly, BIM promotes standardisation of processes and data, ensuring smooth collaboration across disciplines and improving integration with other software tools [8].

2.5.3 BIM Advantages and Challenges

BIM plays a vital role in enhancing efficiency, collaboration, and conflict resolution in construction projects. By integrating design, scheduling, and cost data (3D, 4D, and 5D BIM), it offers a common data environment that reduces ambiguity, eliminates information asymmetry, and enables teams to identify and resolve design inconsistencies before they escalate into formal disputes. This integration improves communication among stakeholders, helping to prevent errors and misalignments that often lead to disputes. BIM's ability to generate detailed virtual models enables teams to identify and address potential design, mechanical, or structural conflicts before construction begins. By facilitating early detection of inconsistencies and fostering collaboration among architects, engineers, and construction managers, BIM minimises costly on-site adjustments and ensures project alignment from the outset. Ultimately, it enhances design accuracy, streamlines collaboration, and supports conflict resolution, contributing to timely, cost-effective, and high-quality project delivery [51&52]. Despite its significant benefits, BIM adoption presents several challenges. High initial costs for software, hardware, and training, coupled with resistance to change among stakeholders, hinder widespread implementation. A lack of standardisation and interoperability issues complicates integration, while skill gaps and a steep learning curve further limit adoption. Collaboration challenges, including stakeholder alignment and data-sharing concerns, add complexity, alongside legal and contractual uncertainties regarding model ownership and liability. Technological limitations, particularly for large projects and small-to-medium enterprises (SMEs) with constrained resources, further restrict BIM's application. Overcoming these barriers requires strategic investment, the establishment of clear industry standards, and broad support from stakeholders to ensure effective BIM integration [5,43,51-53].

2.5.4 Comparative Analysis for Integrating BIM and IPD in Construction Projects

Current research consistently shows that many construction sectors—particularly in the Middle East, North Africa, and parts of Asia—continue to rely heavily on traditional project delivery methods, which remain fragmented and poorly aligned with collaborative digital practices. Studies from Iraq, Saudi Arabia, Egypt, and other Middle Eastern countries highlight limited awareness of IPD, low readiness for integrated workflows, and persistent dependence on conventional contracting. These challenges often lead to rework, delays, coordination problems, and rising project costs. Similar issues are evident in Malaysia's Industrialised Building System (IBS) sector, where most projects still follow traditional procurement and delivery models. This conventional approach has been widely criticised for separating design and construction activities, weakening communication and coordination among project teams, and contributing to frequent rework, time overruns, cost increases, and material wastage. The fragmentation observed in Malaysian IBS projects mirrors the structural inefficiencies identified in Middle Eastern and Egyptian contexts, underscoring the broader regional difficulty in shifting toward integrated and collaborative construction practices. Across these regions, the literature identifies a clear gap in the effective integration of BIM and IPD. Barriers include outdated legal and procurement frameworks, cultural resistance to collaborative contracting, unclear BIM-related roles and liabilities, and the absence of standardised guidelines to support multi-party collaboration. In Egypt specifically, studies indicate that firms often face organisational, technological, and regulatory obstacles that hinder BIM adoption and collaborative project delivery, reflecting similar patterns observed in Iraq and Saudi Arabia. As a result, the potential of BIM and IPD to enhance communication, improve information flow, reduce fragmentation, and strengthen coordination across design and construction stages remains significantly underutilised. The reviewed studies collectively suggest that adopting integrated approaches, particularly BIM-enabled IPD, can help Egypt, Malaysia, Iraq, Saudi Arabia, and other regions address longstanding fragmentation challenges, thereby improving project performance and supporting more efficient, collaborative construction environments [54-58].

2.6 Research Gap

Although the detrimental impact of disputes on construction performance is well established, traditional contracting methods remain dominant despite their growing inadequacy for managing complex, modern projects. These conventional approaches often lead to fragmented communication, limited collaboration, and misaligned objectives, all of which contribute to dispute escalation. As project scale and complexity increase, more integrated delivery strategies are needed. A key gap in current research concerns how BIM and IPD can be theoretically and practically combined to address the legal, organisational, and technological drivers of disputes. While IPD encourages collaboration, shared risk, and transparent decision-making, its adoption is hindered by legal and operational barriers. BIM provides coordinated, real-time project information but is not automatically aligned with IPD processes. The literature lacks a clear theoretical explanation of how BIM can enable or strengthen IPD principles, leaving the integration between the two systems underdeveloped. Existing studies largely examine IPD and BIM independently, offering limited insight into their combined dispute-mitigation potential. According to Miles [59], this represents a theoretical gap, as the mechanisms linking BIM's technological capabilities with IPD's collaborative framework remain insufficiently articulated. It also reflects a secondary knowledge gap, given the scarce empirical exploration of their joint application and synergistic benefits. Thus, further research is needed to establish the theoretical foundations and practical pathways through which BIM can operationalise IPD to improve communication, reduce uncertainty, and ultimately enhance project cost, time, scope, and client satisfaction outcomes.

3. Research Methodology

A mixed research approach consisting of qualitative methods (literature review and case studies) and quantitative methods (survey questionnaire) was designed to accomplish four objectives.

- A systematic literature review was conducted to examine the nature of the construction industry, building procurement, disputes, IPD and BIM. It utilised reputable sources, including textbooks, peer-reviewed journals, conference proceedings, dissertations, industry reports, government publications, and online resources. The review followed a structured six-step process: defining objectives and scope, conducting a literature search, organising and documenting sources, analysing and synthesising findings, evaluating and interpreting sources, and writing and organizing the review [60].
- Four case studies from the United States, India and Egypt were collected and analysed to investigate the role of IPD in resolving project disputes and the consequences of its absence. Case studies were essential in developing effective survey questions by providing a deeper understanding of the nature of the construction industry, building procurement, disputes, IPD and BIM [61&62].
- A survey questionnaire was administered to a representative sample of construction firms in Egypt to assess their perceptions of causes and impacts of disputes; the role of IPD and BIM in eliminating disputes, as well as the challenges of implementing IPD in construction projects in Egypt. The survey comprised four sections: (1) demographic information; (2) knowledge and awareness of causes and impacts of disputes in construction projects; (3) the role of IPD in eliminating disputes in construction projects and the challenges of its implementation; and (4) the effectiveness of BIM in facilitating the implementation of IPD characteristics. A pilot study involving colleagues with expertise in construction, procurement, IPD, and BIM was conducted to determine the effectiveness and limitations of the survey questions. After examining preliminary responses and making revisions, the questionnaire was ready for formal testing [63].
- Based on the above, the research developed a framework integrating IPD and BIM for reducing disputes in construction projects in Egypt, see Fig.1.

A three-stage data analysis procedure was adopted. First, measures of central tendency (mean, median, and mode) and dispersion (variance and standard deviation) were calculated to assess the reliability and consistency of the questionnaire responses. The results demonstrated typical central values and low variability, confirming data quality and homogeneity [64]. Second, the Relative Importance Index (RII) was applied to prioritise the causes and impacts of disputes in construction projects, as well as the challenges associated with implementing IPD and its effectiveness in dispute resolution. The RII was calculated using the formula $RII = W / (A \times N)$, where W is the weight assigned on a five-point Likert scale, A is the highest possible weight, and N is the number of respondents [65]. Data analysis was conducted using Microsoft Excel. Finally, Spearman correlation and regression analyses were carried out to (1) examine the relationship between IPD and BIM characteristics in facilitating effective IPD implementation for dispute reduction, and (2) evaluate the influence of legal, organisational, and technological challenges on the capacity of IPD to minimise disputes, while controlling for firm size and prior IPD/BIM experience. This analysis was performed using the Statistical Package for the Social Sciences (SPSS). Both quantitative and qualitative data analysis methods were employed, emphasising the interplay between quantification and qualification, as statistical analysis requires interpretation [66].

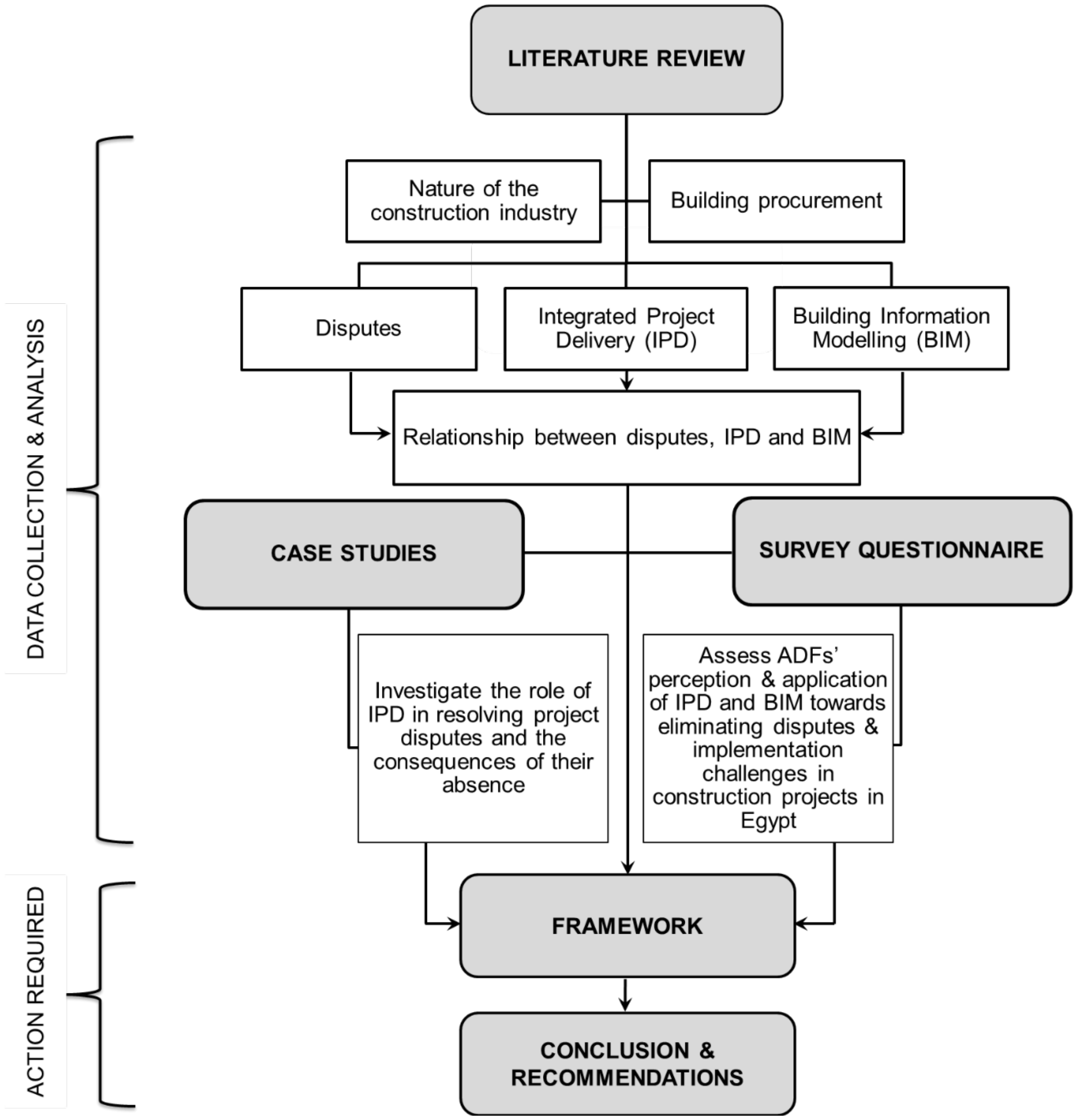

Fig. 1 *Research methodology (developed by the authors)*

3.1 Population and Sampling

For the survey component of this research, the sampling plan employed a random probability sampling approach to ensure that every unit within the defined population had an equal chance of selection. The target population consists of large-sized construction firms in Egypt, as classified by the Egyptian Federation for Construction & Buildings Contractors (EFCBC). According to EFCBC's classification system, construction firms are grouped into seven classes based on company size and project scale; the first three classes constitute large-sized firms, classes four and five represent medium-sized firms, and classes six and seven include small-sized firms. Large-sized firms were selected for this study because they typically undertake complex, large-scale building projects, possess more advanced technological capacities, and demonstrate greater readiness to adopt BIM and IPD-based contractual approaches. The research further narrows its focus to firms operating under the "complete building works" category, as these firms are responsible for delivering entire buildings across various specialties and disciplines—conditions that naturally involve numerous stakeholders and increase the potential for coordination challenges, conflicts, and disputes. Based on the most recent EFCBC records, the total population of large-sized firms engaged in complete building works is 1,367. This defined population served as the basis for determining the appropriate sample size using the following statistical procedures [67].

$$\text{Sample Size Calculation} \frac{\text{Distrubution of 50\%}}{\left[{}^{\text{Margin of error\%}}/_{\text{Confidence Level Score}}\right]^2} \tag{1}$$

$$\text{True Sample} = \frac{\text{Sample Size} \times \text{Population}}{\text{Sample Size} + \text{Population} - 1} \tag{2}$$

In this research, the confidence level chosen is 90% and the margin of error is 5%. The confidence level score corresponding to the confidence level of 90% is 1.645.

$$\text{Sample Size} = \frac{0.5 \times (1 - 0.5)}{\left[{}^{0.05}/_{1.645}\right]^2} = 270.603$$

$$\text{True Sample} = \frac{270.603 \times 1367}{270.603 + 1367 - 1} = 226.025 \sim 226$$

4. Case Studies

4.1 Definition and Selection Criteria

A case study is a research method used to examine and analyse a specific phenomenon, event, or project to identify key variables, interaction patterns, and performance outcomes [68]. This research includes four case studies: two from the USA, one from India, and one from Egypt. The selection criteria were based on project nature, data availability, success level, and geographic diversity. Each case study focused on a construction project, with two demonstrating successful dispute reduction through IPD, while the other two experienced disputes due to the use of traditional procurement methods. Given the limited availability of published case studies on IPD's role in dispute reduction, data accessibility was a crucial factor in the selection process. Additionally, selecting case studies from different countries and cultural contexts provided insights into the global application of IPD in construction projects.

4.1.1 Case Study (1): California Pacific Medical Centre, USA

The Cathedral Hill Hospital project in San Francisco, commissioned by California Pacific Medical Centre, adopted IPD and Lean Construction to overcome challenges related to budget, schedule, disputes and risks. Originally planned as a facility consolidation, it expanded into an 860,000-square-foot, 14-level hospital. A multi-party agreement enabled close collaboration among stakeholders, ensuring efficient delivery. Early contractor and trade partner involvement allowed precise cost estimation and design adjustments through Target Value Design, leading to a 400% return on investment from preconstruction efforts and $80 million in cost savings. Despite entitlement delays, IPD's flexibility improved resource management and schedule predictability. A shared risk/reward pool incentivized performance, while a structured dispute resolution framework fostered transparency and efficient conflict resolution. The project demonstrated how IPD enhances integration, minimises disputes, and drives successful project outcomes in complex construction environments [69].

4.1.2 Case Study (2): Edith Green Wendell Wyatt Federal Building Modernisation, USA

The Edith Green Wendell Wyatt Federal Building Modernisation in Portland, Oregon, was a large-scale renovation led by General Services Administration (GSA), incorporating IPD to enhance cost control, schedule efficiency, dispute resolution and risk management. Initially planned under a traditional design-bid-build model, it was re-scoped in 2009 under the American Recovery and Reinvestment Act programme, requiring rapid execution and alignment with high-performance green building standards. The project benefited from early trade involvement, open-book financial practices, co-location, and BIM, enabling cost predictability and reducing change orders. Risk was managed through performance-based incentives and shared responsibility, fostering collaboration and flexibility. Disputes were addressed through a structured alternative dispute resolution process, ensuring efficient conflict resolution through negotiation, mediation, and arbitration before litigation. The project demonstrated how IPD enhances project transparency, reduces risks and disputes, as well as improves efficiency, setting a precedent for GSA's future adoption of collaborative delivery methods [70].

4.1.3 Case Study (3): Dr Prabhu Halakatti Hospital, India

The third case study explores a hospital project in India that faced challenges due to the use of the traditional procurement approach. While this method was chosen to finalise the design before contractor appointment, ensuring cost and requirement clarity, it led to significant issues during planning and construction. Poor communication among stakeholders, project delays, and cost overruns, mainly due to client-initiated changes hindered project success. The absence of IPD contributed to coordination failures, escalating disputes and inefficiencies. Consequently, the hospital client lost confidence in traditional procurement and began exploring alternative approaches, particularly IPD, which fosters collaboration and shared responsibility. This case underscores how the lack of IPD can lead to disputes and project setbacks, highlighting the need for more integrated procurement methods [6].

4.1.4 Case Study (4): Public Faculty Building, Egypt

The case study examines a faculty building project at a public university in Egypt, covering 7,200 square meters with an estimated budget of EGP 33 million. The project followed the Design-Bid-Build approach, excluding the contractor and construction professionals from the design phase. This lack of early collaboration led to significant construction challenges, including the need for design modifications such as additional windows for natural lighting, upgraded roof insulation to improve energy efficiency, and a structural system change to better suit functional needs. These alterations resulted in an extra cost of EGP 550,397 and a 75-day delay. The absence of IPD contributed to miscommunication, disputes, cost overruns, and inefficiencies, as issues that could have been addressed early instead required costly adjustments during construction. This case highlights how traditional procurement methods can lead to disputes and inefficiencies, whereas IPD could have facilitated better coordination, reducing delays and enhancing project outcomes [71].

5. Results

This section presents and analyses the results of a survey questionnaire conducted with a representative sample of construction firms in Egypt to examine their perception of causes and impacts of disputes; the role of IPD and BIM in eliminating disputes, as well as the challenges of implementing IPD in construction projects in Egypt.

5.1 Response Rate and Respondents' Profile

Out of 226 construction firms invited to participate in the study, 144 firms responded to the survey questionnaire, achieving a response rate of 63.7%. The survey includes participants with diverse levels of experience, ensuring a comprehensive and realistic representation of the construction industry regarding disputes, IPD, and BIM implementation. Among the respondents, 13% have over 20 years of experience, 35% have 10–20 years, 22% have 5–10 years, and the remaining have 1–5 years of experience. Additionally, 40.2% of the respondents are involved in infrastructure and heavy construction projects. This is significant, as large-scale projects are well-suited for IPD and BIM adoption and are more prone to disputes due to their complexity. The survey results, therefore, provide valuable insights into industry practices and challenges in implementing these methodologies. The survey reveals that design-bid-build is the most commonly used contract type in Egyptian construction firms, despite its disadvantages, including a higher risk of disputes and challenges in BIM integration. This finding is essential for developing an effective framework for IPD implementation. Additionally, some firms have already adopted IPD to a limited extent, indicating that a small portion of the industry is equipped for BIM and IPD integration. This suggests potential for broader adoption in the future.

5.2 Perception of Causes and Impacts of Disputes in Construction Projects in Egypt

Respondents were asked to rate the causes of disputes in construction projects on a scale of 1 to 5 to assess their relative significance. "Time extensions and contractor's inability to meet deadlines" emerged as the most critical cause, with a mean score of 3.92, median of 4, mode of 5, variance of 1.54, standard deviation of 1.24, and RII of 0.72. This indicates both a high level of perceived importance and considerable agreement among respondents regarding its impact. Following closely, "Delays in work progress" was identified as another major cause, with a mean of 3.88, median of 4, mode of 5, variance of 1.55, standard deviation of 1.24, and RII of 0.69. These findings, summarised in Table 2 and illustrated in Fig. 2a, demonstrate that delays related to scheduling and progress are primary drivers of disputes, emphasising the need for effective time management, clear scheduling, and proactive monitoring to reduce conflicts in construction projects.

Table 2 *The causes of disputes in construction projects in Egypt against their measures of central tendency, dispersion and ranking (developed by the authors)*

No. (1)	Mean (2)	Median (3)	Mode (4)	V (5)	SD (6)	Percentage of Respondents Scoring			RII (10)	Rank (11)	Final Rank (12)
						< 3 (7)	3 – 4 (8)	> 4 (9)			
CD (1)	3.92	4	5	1.54	1.24	21	61	62	0.72	(1)	1
CD (2)	3.88	4	5	1.55	1.24	22	63	59	0.69	(2)	2
CD (3)	3.86	4	5	1.53	1.24	22	65	57	0.67	(3)	3
CD (4)	3.81	4	5	1.56	1.25	23	68	53	0.62	(4)	4
CD (5)	3.77	4	5	1.55	1.24	24	70	50	0.59	(5)	5
CD (6)	3.76	4	5	1.54	1.24	24	71	49	0.57	(6)	6
CD (7)	3.72	4	4	1.57	1.25	25	72	47	0.55	(7)	7
CD (8)	3.72	4	4	1.56	1.25	25	73	46	0.54	(8)	8
CD (9)	3.69	4	4	1.54	1.24	25	75	44	0.52	(9)	9
CD (10)	3.69	4	4	1.54	1.24	25	75	44	0.52	(10)	10
CD (11)	3.61	4	4	1.54	1.24	27	79	38	0.44	(11)	11

Respondents were asked to rank the impacts of disputes in construction projects on a 1–5 scale. "Project delay" was identified as the most significant impact, with a mean of 3.76, median and mode of 4, variance of 0.86, standard deviation of 0.93, and an RII of 0.75. This was followed by "Cost overrun" (mean = 3.60, median/mode = 4, variance = 0.92, SD = 0.96, RII = 0.73). The results indicate that project delays and cost overruns are major drivers of disputes, often leading to contractual conflicts, financial disagreements, schedule disruptions, and strained stakeholder relationships [14][15]. These findings are summarised in Table 3 and illustrated in Fig. 2b and Table 3. The impact of disputes in construction projects in Egypt against their Measures of Central Tendency, Dispersion and Ranking (Developed by the Authors)

Table 3 *Impacts of disputes in construction projects in Egypt against their measures of central tendency, dispersion and ranking (developed by the authors)*

No. (1)	Mean (2)	Median (3)	Mode (4)	V (5)	SD (6)	Percentage of Respondents Scoring			RII (10)	Rank (11)	Final Rank (12)
						< 3 (7)	3 – 4 (8)	> 4 (9)			
ID (1)	3.76	4	4	0.86	0.93	18	80	46	0.75	(1)	1
ID (2)	3.60	4	4	0.92	0.96	22	85	37	0.73	(2)	2
ID (3)	3.05	3	3	1.04	1.02	43	80	21	0.61	(3)	3
ID (4)	2.96	3	3	1.08	1.04	50	75	19	0.59	(4)	4

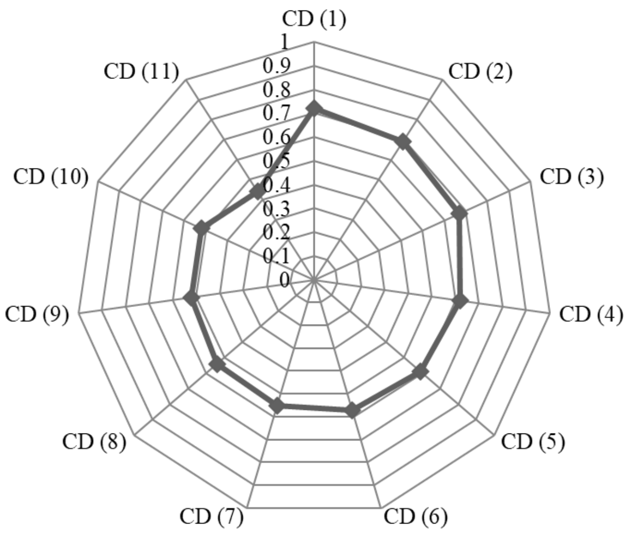

Fig. 2a *RII of causes of disputes in construction projects in Egypt (developed by the authors)*

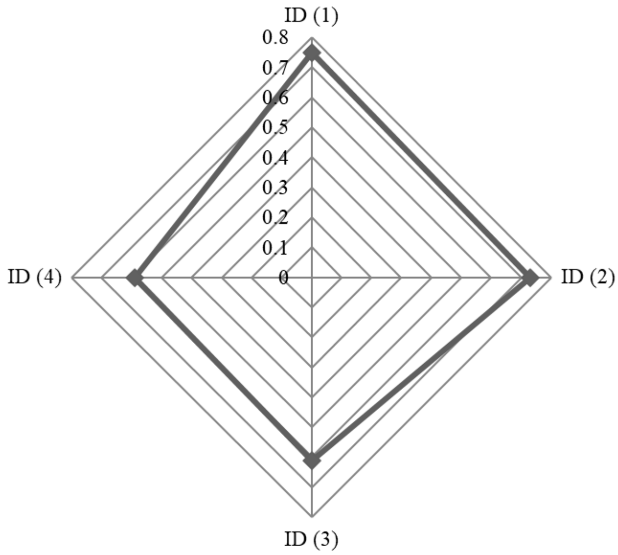

Fig. 2b *RII of impacts of disputes in construction projects in Egypt (developed by the authors)*

5.3 Perception and Application of IPD and BIM Integration Towards Eliminating Disputes in Construction Projects in Egypt

The survey results revealed that 48% had low awareness of IPD, while 29% reported moderate awareness, and 23% indicated high or very high awareness. Respondents highlighted that IPD can play a crucial role in reducing disputes, particularly by addressing issues such as limited availability of critical project information and lack of effective communication. These findings underscore the potential of IPD to enhance collaboration and minimise conflicts in construction projects, as supported by previous studies [45-47].

- Regarding BIM, the survey indicated that 85% of respondents have moderate to extremely high awareness. Additionally, 94% agreed that BIM is a valuable tool for supporting IPD in reducing disputes, primarily due to its capabilities in ensuring data consistency and accuracy, enhancing visualisation, facilitating quantity take-offs, enabling multi-user collaboration, and contributing to energy efficiency and sustainability. Furthermore, 95% of respondents emphasized the need for a structured framework integrating BIM and IPD, which would provide guidance for effective implementation in construction projects and promote better dispute resolution and overall project efficiency.
- Despite widespread BIM adoption, limited IPD awareness indicates that many firms still operate under traditional, adversarial structures. Without accompanying organisational and contractual reforms, BIM's collaborative potential is underutilised, highlighting the need for training, policy support, and standardised IPD practices to fully reduce disputes.
- Results of survey and case studies consistently show that BIM and IPD together enhance collaboration, improve communication, reduce ambiguities, and mitigate disputes in Egyptian construction projects. Case studies provide qualitative depth, while surveys confirm industry-wide agreement on these benefits.

5.4 Correlation and Regression Analysis of IPD Challenges in Construction Projects in Egypt

A correlation analysis test was conducted on the challenges of IPD implementation for reducing disputes in construction projects to investigate their correlations. The Spearman correlation test was carried out using SPSS to perform this type of analysis as all the variables are ordinal and categorical. While SPSS highlighted that some challenges are correlated, others were not. For example, organisational and legal challenges in IPD implementation are closely interconnected, as legal complexities often disrupt organizational structures, while organisational inefficiencies amplify legal risks. The complexity of multi-party contracts, unclear risk allocation, and regulatory compliance create legal uncertainties that hinder smooth project execution. Simultaneously, resistance to collaboration, liability concerns, and difficulties in aligning with existing workflows make legal compliance and contract enforcement more challenging. Moreover, ineffective dispute resolution mechanisms can escalate conflicts rather than mitigate them. Ultimately, the interplay between legal and organisational challenges significantly impacts the effectiveness of IPD in minimising disputes in construction projects. on the other hand, the analysis showed a low correlation between "technological issues challenges" and "legal issues challenges" which can be attributed to their relatively independent nature. While legal challenges focus on contracts, risk allocation, and regulatory compliance, technological challenges primarily involve the adoption and integration of digital tools like BIM, cloud collaboration, and project management software. Although legal frameworks may influence data security and intellectual property rights, these concerns are typically addressed through standardised agreements rather than creating significant legal disputes. Additionally, technological advancements generally enhance collaboration and transparency, which can help mitigate conflicts rather than exacerbate legal risks. As a result, while both challenge areas impact IPD implementation, they do not directly reinforce each other in a way that significantly influences dispute resolution, see Table 4.

Table 4 *Spearman correlation for challenges of IPD implementation for reducing disputes in construction projects in Egypt (developed by the authors)*

		Legal issues challenges	Organizational issues challenges	Technological issues challenges
Legal issues challenges	Correlation Coefficient	1.000	0.663	0.392
	Sig. (2-tailed)	.	<.001	<.001
	N	144	144	144
Organizational issues challenges	Correlation Coefficient	0.663	1.000	0.554
	Sig (2-tailed)	<.001	.	<.001
	N	144	144	144
Technological issues challenges	Correlation Coefficient	0.392	0.554	1.000
	Sig. (2-tailed)	<.001	<.001	.
	N	144	144	144

Regression analysis was conducted to assess the impact of legal, organisational, and technological challenges on the effectiveness of IPD in reducing disputes, controlling for firm size and prior IPD/BIM experience. Results showed that legal and organisational challenges had the strongest negative effects, with multi-party contracts, unclear risk allocation, regulatory compliance, and resistance to collaboration significantly reducing dispute mitigation effectiveness. Technological challenges had a smaller, yet meaningful, impact, primarily supporting collaboration and data management. Interactions revealed that organisational inefficiencies amplify legal challenges, while technological solutions help moderate these effects. Overall, regression provided quantitative insights beyond correlation, highlighting the relative importance of each challenge and offering actionable guidance for effective IPD implementation, see Table 5.

Table 5 *Regression analysis of IPD challenges on dispute reduction in construction projects in Egypt (N = 144) (developed by the authors)*

Challenge Category	Coefficient (β)	Standard Error	Odds Ratio (Exp(β))	p-value	Interpretation
Legal issues	-1.42	0.31	0.24	<0.001	Strong negative effect on IPD effectiveness
Organizational issues	-1.08	0.28	0.34	<0.001	Significant negative impact, interacts with legal challenges.
Technological issues	-0.48	0.21	0.62	0.025	Moderate negative effect; improves transparency and coordination
Firm size (control)	0.12	0.09	1.13	0.18	Not statistically significant
Prior IPD/BIM experience (control)	0.57	0.14	1.77	<0.01	Positive effect on dispute reduction

While the findings are context-specific to Egypt's construction sector—particularly large firms—they may also be relevant and potentially applicable to countries or regions with similar industry characteristics, such as fragmented procurement, hierarchical decision-making, and comparable technological readiness. Nevertheless, caution is required when extrapolating these results to contexts with different institutional frameworks, market conditions, or firm sizes.

6. A BIM-IPD Integrated Framework for Reducing Disputes in Construction Projects in Egypt

According to the results of the literature review, case studies and survey questionnaire, the research proposed the development of a framework integrating BIM and IPD to reduce disputes in construction projects in Egypt.

6.1 Definition and Background

A framework provides a structured model that outlines the concepts, processes, and technologies required to achieve desired outcomes in a product or project development environment [72]. The proposed BIM-IPD Framework (BIM-IPDF) combines BIM and IPD within a theoretically grounded structure informed by organisational theory, particularly socio-technical systems and information-processing theory, and by collaborative contracting theory, which emphasises trust, transparency, and shared risk.

6.2 The Need for the Framework

Construction projects in Egypt continue to rely heavily on traditional procurement systems characterised by hierarchical decision-making, siloed responsibilities, and adversarial relationships. Organisational theory suggests that such structures increase uncertainty, weaken coordination, and heighten the likelihood of disputes. The BIM-IPDF responds to these challenges by introducing a structured model that leverages BIM's ability to enhance information transparency and IPD's foundation in relational contracting. Together, they create a socio-technical environment where trust, shared objectives, and integrated teams can flourish—conditions strongly supported by collaborative contracting literature. The framework is thus essential for:

i. Providing structured procedures to minimise dispute triggers,
ii. Supporting Egypt's transition from transactional to relational contracting environments,
iii. Addressing the industry's limited familiarity with IPD and fragmented BIM adoption,
iv. Filling a theoretical and practical gap regarding IPD implementation in Egypt's organisational landscape.

6.3 Development of the Framework

The development of the framework was based on the results of the literature review, case studies and data analysis gleaned from the survey questionnaire.

- The literature review investigated the nature of the construction industry, causes and impacts of disputes in construction projects and building procurement. Moreover, IPD and BIM advantages, challenges and characteristics aligned with organisational information-processing theory (improving coordination capacity) and collaborative contracting theory (enhancing trust and alignment) towards reducing disputes in the construction industry were discussed. This analysis revealed a theoretical gap: while BIM and IPD each address organisational fragmentation, their combined effect on dispute reduction in Egypt remained underexplored.
- Case studies showed that projects applying IPD achieved superior performance due to relational governance, early collaboration, and enhanced information flow consistent with relational contracting theory—while traditional systems failed to prevent disputes.
- Analysis of the survey questionnaire responses confirmed the significant impact of IPD contracts in reducing disputes in Egyptian construction projects and ranked their impact on the industry, as well as identified the most responsible project parties. Findings also ranked challenges to IPD implementation and linked BIM attributes to IPD characteristics. These insights guided the framework development by prioritising key dispute causes and overcoming barriers to IPD and BIM adoption.

6.4 Aim of the Framework

The IPDIF is an innovative conceptual business improvement tool designed to facilitate the integration of BIM and IPD to reduce disputes in construction projects in Egypt. This will help enhance the performance of construction projects and collaboration among project stakeholders.

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6.5 The Conceptual Description of the Framework

The framework is developed following the DMAIC improvement process, which stands for Define, Measure, Analyse, Improve, and Control. DMAIC serves as a meta-routine, facilitating the enhancement of existing processes or the development of new ones. It is widely recognized as a systematic approach to problem-solving and continuous improvement [73]. The framework consists of five phases, as shown in Fig. 3.

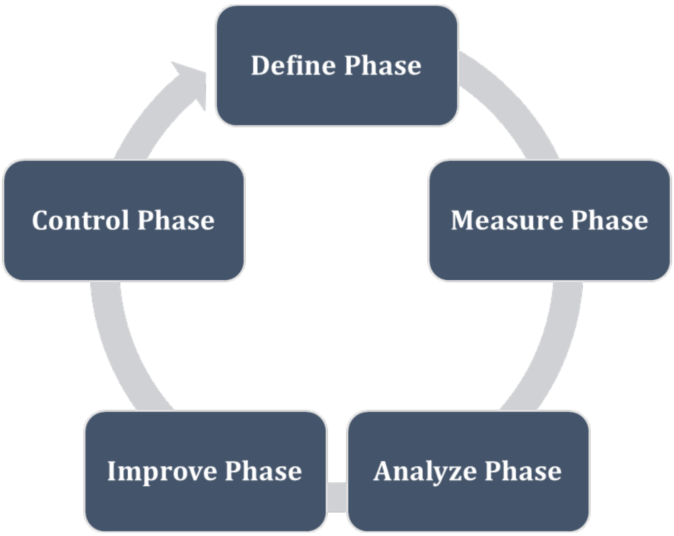

Fig. 3 *Phases of the framework (developed by the authors)*

6.5.1 Define Phase

The define phase focuses on identifying the root causes of conflicts and establishing clear project objectives. This phase ensures that all stakeholders, including the project client, architects, engineers, contractors, and legal advisors are aligned within a collaborative environment which minimises adversarial relationships. Key activities involve:

- Identify the most common causes of disputes in construction projects.
- Categorize disputes based on legal, organisational, and technological factors.
- Establish key objectives for mitigating disputes through IPD and BIM implementation.
- Develop a BIM execution plan to standardize workflows and data-sharing protocols.
- Define IPD contractual frameworks to establish risk-sharing mechanisms.
- Map project scope using the SIPOC model to clarify the roles of suppliers, inputs, processes, outputs, and customers, ensuring a structured approach to dispute prevention.

The tools and techniques required to achieve these activities include meetings, BIM coordination models for early clash detection, risk management matrices to categorise potential disputes and stakeholder engagement workshops to ensure alignment. To support this phase, BIM collaboration software such as Autodesk Revit and Navisworks is utilised to enhance project visualization and coordination. IPD contracts, legal agreements, and risk registers provide a structured foundation for dispute resolution. Involved personnel include the project client, architects, engineers, general contractor and subcontractors, as well as legal and contract advisors. The implementation strategy emphasises establishing a common data environment for real-time collaboration, conducting collaborative workshops to align expectations, and integrating dispute-resolution mechanisms within the IPD framework. These steps ensure that all project participants work towards a shared vision, reducing misunderstandings and enhancing proactive dispute management.

6.5.2 Measure Phase

The measure phase focuses on quantifying the impact of disputes on cost, time, and quality while identifying key metrics to track dispute occurrences and resolution timelines. Key activities include:

- Assess the frequency and severity of disputes in construction projects.
- Evaluate the impact of disputes on project cost, schedule, scope, and stakeholder relationships.
- Gather industry insights through surveys, case studies, and expert consultations.

The tools and techniques required to achieve these activities include BIM clash detection reports to monitor coordination issues, while dispute logs and heat maps visualise conflict-prone areas. Project management software like Procore and Primavera further support this phase by tracking delays and cost overruns, ensuring comprehensive data collection for analysis. To implement this phase effectively, involved personnel, including the BIM coordinator, project manager, cost estimators, and legal specialists, utilise key resources such as BIM clash detection reports, dispute databases, and project performance dashboards. To ensure success, implementation strategies include establishing real-time BIM dashboards for ongoing dispute tracking and risk analysis using historical data to identify trends in conflict resolution. Additionally, digital twin technology is leveraged to simulate dispute scenarios, allowing teams to proactively assess and address potential risks before they escalate. This structured, data-driven approach ensures that disputes are not only measured but also systematically analysed, leading to more effective resolution strategies.

6.5.3 Analyse Phase

The Analyse Phase aims to identify the root causes of disputes and process inefficiencies by examining both contractual and technical factors contributing to conflicts. Key activities include:

- Perform root cause analysis using BIM data and dispute reports
- Review contractual obligations within IPD framework
- Analyse historical project data to detect recurring conflict trends.

The tools and techniques required to achieve these activities include the 5 Whys and Fishbone Diagrams to systematically trace conflict origins, while AI-powered predictive analytics enhance the ability to foresee disputes before they escalate. These methods collectively enable project teams to address the fundamental causes of disputes rather than just their symptoms. To implement this phase effectively, BIM modellers, project engineers, contract administrators, and legal experts collaborate using essential resources like BIM clash detection reports, legal contract reviews, and historical dispute data. To ensure success, implementation strategies should include AI-driven dispute prediction tools integrated into BIM platforms to proactively identify potential issues, and multidisciplinary contract review sessions should ensure that risk-sharing frameworks in IPD agreements are clear and enforceable. Additionally, digital simulations are utilised to test conflict-resolution scenarios, allowing project teams to refine their dispute mitigation strategies in a controlled virtual environment. By systematically analyzing the underlying causes of disputes, construction teams can develop proactive solutions, leading to more efficient project execution and reduced conflicts.

6.5.4 Improve Phase

The Improve phase focuses on implementing effective strategies to prevent and resolve disputes while optimising communication and project workflows. Key activities include:

- Conduct real-time BIM coordination to allow stakeholders to proactively address conflicts before they escalate.
- Apply smart contracts, based on blockchain technology and IPD agreements, to automate payments, enforce contractual obligations and reduce financial disputes.
- Organise Virtual Reality (VR) and Augmented Reality (AR) walkthroughs to enabling project teams to visualise potential issues before construction begins.

To achieve these activities, architects, engineers, contractors, IT and BIM specialists, and financial advisors leverage key tools such as VR/AR technology for interactive design reviews, AI-powered contract analysis for dispute detection, and lean construction techniques for process optimisation. Pilot testing of BIM-based dispute prevention techniques helps refine strategies before full-scale implementation, while collaborative issue-resolution meetings become a standardised practice to ensure continuous communication. Additionally, Lean BIM workflows are introduced to streamline coordination and minimise inefficiencies. By integrating these advanced technologies and methodologies, construction teams can create a proactive dispute-resolution framework, fostering efficiency, accountability, and smoother project execution.

6.5.5 Control Phase

The control phase ensures that dispute-resolution improvements are sustained over the long term and standardised for future construction projects. Key activities involve:

- Develop BIM-enabled monitoring dashboards to track disputes and measure their impact,
- Establish Standard Operating Procedures (SOPs) for dispute resolution.
- Conduct post-project evaluations to document lessons learned and help teams refine their approaches for future projects.

Key stakeholders in this phase include facility managers, project auditors, quality assurance teams, and legal compliance officers, who utilise BIM-based performance monitoring dashboards, control charts, and KPI tracking systems to measure dispute trends and ensure compliance with best practices. Continuous improvement training programs are implemented to enhance dispute management capabilities, while historical project data is analysed to refine conflict-resolution strategies. Furthermore, feedback loops are established to incorporate insights from past projects, ensuring that dispute prevention measures evolve with industry advancements. Through these strategies, construction teams can sustain efficiency, reduce risks, and enhance overall project performance.

6.6 Benefits and Limitations of the Framework

The proposed framework provides a structured approach to integrating BIM and IPD through the DMAIC improvement process, offering clear steps to minimise and prevent disputes in construction projects. While many companies adopt elements of IPD and BIM separately, this framework ensures their collective implementation for greater efficiency. The integration of BIM and IPD not only addresses the technical and contractual causes of disputes but also introduces a transformative organisational model that mitigates conflict, enhances cooperation, and supports more harmonious project delivery. However, its application in Egyptian construction companies faces challenges, primarily due to the lack of governmental support for IPD contracts, outdated technological infrastructure, and the need for BIM training among employees. Additional limitations include data availability, project managers' awareness, contracting culture focused on execution over planning, and financial constraints. Overcoming these barriers would require policy changes, investment in technology, and capacity-building initiatives.

7. Conclusion and Recommendations

The traditional procurement approach, which is widely adopted in the construction industry, has been a significant contributor to project disputes due to its inherent flaws and inefficiencies. One of its primary limitations is the separation of design from construction, which restricts the integration of contractors' and construction professionals' expertise into the design process. This lack of early collaboration often results in design errors, constructability issues, and scope ambiguities, leading to frequent changes, delays, and cost overruns. Furthermore, traditional procurement methods are characterised by rigid contractual structures, adversarial relationships, and fragmented responsibilities, which create communication gaps between stakeholders. These factors contribute to disputes arising from unclear risk allocation, contract misinterpretations, delays in approvals, and payment disputes, ultimately affecting project efficiency and stakeholder relationships. Although various dispute-resolution strategies, such as Total Quality Management, robust design, reliability analysis, and quality function deployment, have been introduced, the limitations of traditional processes continue to hinder effective conflict mitigation. As a result, unresolved disputes lead to project delays, budget overruns, productivity losses, and strained stakeholder relationships. IPD offers a transformative solution by fostering collaboration through the integration of people, systems, business structures, and project workflows. This approach enhances project outcomes by optimising efficiency, reducing conflicts, and addressing procurement inefficiencies. In parallel, BIM serves as a powerful tool within the IPD framework, facilitating real-time coordination, improved communication, and proactive dispute mitigation. By combining IPD and BIM, construction projects can overcome the inefficiencies of traditional procurement, ensuring smoother collaboration, reduced disputes, and enhanced project performance. Given the rapid expansion of mega-construction projects in Egypt, disputes among stakeholders have intensified, underscoring the need for a more integrated and technology-driven approach. This paper proposes a comprehensive framework that leverages the integration of IPD and BIM to mitigate disputes in Egyptian construction projects by addressing systemic inefficiencies, fostering stakeholder collaboration, and enhancing technological integration to achieve higher efficiency and project success. During this research, a literature review was used to examine the nature of the construction industry, building procurement, disputes, IPD and BIM. In addition, four case studies were analysed to investigate the role of IPD in resolving project disputes and the consequences of using traditional procurement approaches. Furthermore, results of a survey questionnaire conducted with a representative sample of construction firms in Egypt showed that design-bid-build remains the dominant contract type despite its high dispute risks and BIM integration challenges. While some firms have partially adopted IPD, there is potential for broader implementation. The top dispute causes were time extensions and delays in work progress, with project delays and cost overruns being the most significant impacts. Awareness of IPD was low among 48% of respondents, while 85% had moderate to high awareness of BIM, with 94% recognising its role in supporting IPD. Additionally, 95% emphasised the need for a BIM-IPD integration framework to improve implementation and dispute resolution. A Spearman correlation analysis showed a strong link between organisational and legal challenges due to legal complexities and inefficiencies, while technological and legal challenges had a low correlation, as BIM enhances transparency rather than increasing legal risks. Regression analysis showed that legal and organisational challenges are the main factors undermining the effectiveness of IPD in reducing disputes, driven by unclear risk allocation, complex multi-party contracts, regulatory demands, and limited collaboration. Technological challenges had a smaller but supportive influence by improving data management and coordination. The results also revealed that organisational inefficiencies worsen legal constraints, while technological tools can help mitigate them. Although derived from the Egyptian construction sector, the findings may be relevant to similar markets, but should be generalised with caution.

Based on the above, the research proposed a framework integrating IPD and BIM to reduce disputes in construction projects in Egypt. Accordingly, the research comes to the following recommendations to address the challenges of IPD and BIM integration towards reducing disputes in construction projects.

1. Encourage early involvement of all project stakeholders through the IPD approach to enhance collaboration, minimise design errors, improve constructability, and reduce project risks. This could be achieved through shifting from traditional procurement models to more flexible, collaborative contracting structures that emphasise shared risk and reward, enhance transparency, and improve project execution through better communication and cooperation.
2. Expand educational programs and workshops to address knowledge gaps in IPD and BIM adoption, ensuring construction professionals are equipped with the skills to implement these approaches effectively. This could be attained by fostering industry collaboration, promoting open communication, sharing best practices, and leveraging professional organisations to disseminate successful case studies and innovative dispute mitigation strategies.
3. Address legal and organisational challenges by developing standardised contracts and flexible legal frameworks that facilitate IPD and BIM implementation. Ensure these frameworks align with collaborative principles to minimise risks, clarify responsibilities, and promote smooth project execution.
4. Promote BIM as a tool for transparency, real-time decision-making, and enhanced project coordination to reduce disputes and improve visualisation. This could be achieved through encouraging its integration with IPD to facilitate seamless collaboration and early issue identification, ultimately enhancing project efficiency.
5. Minimise project delays and costly disputes by adopting conflict resolution protocols, early warning systems, and clear risk allocation strategies. This could be attained by integrating these measures alongside IPD and BIM to create a structured approach for identifying and mitigating potential conflicts before they escalate.
6. Conduct further research on the long-term impacts of IPD and BIM integration in mega-construction projects, particularly in Egypt and other emerging markets, as well as investigating adoption barriers, dispute reduction effectiveness, and strategies for refining implementation to guide industry practices and broader adoption.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm their contribution to the paper as follows: ***Study conception and design:*** *Ayman Ahmed Ezzat Othman, Alaa Mohamed Sayed;* ***data collection:*** *Alaa Mohamed Sayed;* ***analysis and interpretation of results:*** *Ayman Ahmed Ezzat Othman, Alaa Mohamed Sayed;* ***draft manuscript preparation:*** *Ayman Ahmed Ezzat Othman. All authors reviewed the results and approved the final version of the manuscript.*

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