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Improving Payment Management in Construction with Blockchain and Smart Contracts

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Abstract

The construction industry is grappling with financial challenges related to payment management. Payment delays, contract complexity, lack of transparency, and dispute resolution are some critical issues contributing to this problem. These payment issues often lead to unintended consequences such as delays, increased costs, decreased performance, disputes, and bankruptcy. Implementing standardized payment practices and adopting technology can help address these issues. This research analyzed 60 articles, which were narrowed down to 13 relevant articles, and found that "smart contracts", "construction contracts", "blockchains", and "blockchain technologies" were the most significant contributors to improving payment processes. The analysis results found that smart contracts and blockchain technology can increase transparency, collaboration, and automation, improving payment administration and dispute resolution processes. Innovative blockchain-enabled frameworks can also address the power imbalance in construction payments. By leveraging technology, the construction industry can improve payment management practices and enhance transparency, reducing the unintended consequences of payment issues.

Keywords: Payment Management, Construction Project, Blockchain Technologies, Smart Contracts

1. Introduction

Effective payment management is crucial in construction projects to ensure financial stability and the smooth progression of activities. Payment management includes the processes, systems, and protocols that facilitate the timely and accurate payment of contractors, subcontractors, suppliers, and other stakeholders involved. Despite its critical importance, payment management is fraught with challenges that can compromise the efficiency and financial health of construction projects. This research delves into the current state of issues surrounding payment management in construction projects, drawing insights from recent studies. The findings will provide a comprehensive understanding of the challenges faced in payment management and offer recommendations for improvement.

Current State of Issues

Delayed Payments:

The management of payments in construction projects poses a notable challenge to the industry. The financial issues of clients, including payment delays, money problems, and economic woes, are a potential source of delays in construction projects (Abdul-Rahman et al., 2009). Among the most persistent issues is the delay in payments, which can have adverse effects such as hampered cash flow, strained relationships among project stakeholders, and slowed project progression. These adverse effects severely impact the construction sector, resulting in delays, costs, and time overruns (Jeffrey Boon Hui et al., 2021). These delays can be attributed to bureaucratic processing, disputes over work quality or completion, and the complex structure of construction contracts. Late payments by the employer negatively impact the contractor's cash flow, and in many cases, this leads to the postponement of payments to subcontractors and suppliers (Ahmadisheykhsarmast & Sonmez, 2020).

While payments are the lifeblood of construction projects, steady fund flows are rare in practice (Ramachandra & Rotimi James Olabode, 2015). Payment issues lead to several undesirable consequences, such as delays, increased costs, reduced performance, disputes, and bankruptcies, which could jeopardize project success (Ahmed, 2003; Sambasivan & Soon, 2007; Tran & Carmichael, 2012). Project delays are one of the most prevalent, expensive, complex, and challenging issues encountered in construction projects (Ameer-A & NAN, 2006; Chin Keng et al., 2020). Payment problems are the primary cause of disputes in construction projects (Kartam & Kartam, 2001; Liu et al., 2019; Ramachandra & Rotimi, 2011; Ramachandra & Rotimi James Olabode, 2015).

In light of the above, an effective cash flow management strategy is crucial to completing the project on time and within budget (Muller & Ward, 2013). The main reason for the delays is money problems (Adam, 2017). Therefore, construction industry stakeholders must implement effective payment processes and strategies to mitigate the risks associated with

payment delays and other financial issues that could impact project success.

Dispute Resolution:

Disputes are an inherent aspect of construction projects due to their complexity and the involvement of multiple parties. However, payment-related disputes pose a significant challenge when it comes to resolving them. The reasons for disputes on construction projects are often due to claims or disagreements associated with changes in conditions, additional work, and contract times (Awwad et al., 2016; Mikhail Carol. & Serag, 2019; Wideman & Eng, 1990). Claims can be defined as assertions of the right to property, money, remedy, lost time, relief, or compensation for damages made by any party to the contract (Kumaraswamy, 1997; McGeorge et al., 2007; Semple et al., 1994). Besides, increased costs, delays, and negative impacts on the parties' future relationships and communication often disrupt the flow of work due to conflicts and disputes (Harmon Kathleen M., 2003; Jagannathan & Delhi Venkata Santosh, 2019; Ng Helen. et al., 2007).

Payment problems are a widespread issue in the construction industry that has been a source of concern for decades (Ramachandra & Rotimi James Olabode, 2015). Payment-related problems have been increasingly causing disputes in the construction industry, which directly impacts the success of construction projects and the industry's survival (Cheng et al., 2010). Common payment problems, such as delays and non-payments, are often caused by deliberate and/or unintentional actions of upper-tier construction parties in many countries (Ramachandra & Rotimi James Olabode, 2015). For instance, delays in approving contractors' invoices/claims, settling payments, and releasing retention monies have had significant impacts on constructors' cash flows (Odeyinka et al., 2008). Failure to make payments within stipulated timeframes means that contractors would have to incur additional financing and transaction costs, which increases their risk of insolvency (Euginie, 2006; Odeyinka & Kaka, 2005). Payment irregularities are a significant cause of disputes (Chan & Suen, 2005; Kennedy., 2006). Non-compliance with payment provisions and irregular processing of valuations for interim, final, and variation claims cause disputes between project owners and constructors on construction projects (Ramachandra & Rotimi James Olabode, 2015). There are instances where disputes arose between construction parties because of non-payment. For example, New Zealand reported that a building contractor was not paid an interim payment of about $265,000 on an apartment development project because the project owner (developer) refused to pay the contractor for incomplete works and delays (Gibson, 2004). Similarly, a prominent developer opposed a bankruptcy application brought by one contractor (Gibson, 2010). In this situation, the developer owed the contractor nearly $1 million for a $100 million Hotel complex.

Although not all contracts accurately capture the relationship between the parties (Gupta & Venkataraman, 2010), when a dispute occurs, it could turn into a disagreement that may not be resolved amicably by the party involved (Arditi et al., 2009; Barrie & Paulson, 1992; Jagannathan et al., 2021). Both arbitration and litigation are traditional means of dispute resolution in the construction industry (Jagannathan & Delhi Venkata Santosh, 2019, 2020; Treacy Thomas., 1995). Litigation usually demands significant expenses and lengthy project delays (Cheung et al., 2002). However, disagreements can lead to litigation (Torchia & Calabrò, 2018). To avoid this delay in litigation, ADR processes such as mediation, adjudication, arbitration, and other hybrid methods have evolved (Brown & L M, 1999; Haugen & Singh, 2015; Kaplan et al., 1991; Rosenberg & Folberg, 1993; Stipanowich, 2004). The lack of a streamlined, universally accepted dispute resolution mechanism continues to be a significant barrier to efficient payment management.

Lack of Transparency and Inaccurate Documentation:

The construction industry is often faced with issues concerning transparency and accuracy in documentation, which can have a direct impact on payment management. Inaccuracies in billing, inadequate documentation of completed work, and the non-transparent nature of certain financial transactions can cause disputes and delays in payments. Construction progress payments are critical to the successful delivery of a project and the financial well-being of all stakeholders (Barrie & Paulson, 1992; Navon., 1996). The construction industry currently relies on traditional contracts and information-intensive payment applications, which are time-consuming to prepare and rely heavily on human-centered workflows (Hesam & Martin, 2021). As a result, project stakeholders often suffer from late or non-payments (Peters et al., 2019), making the architectural, engineering, and construction (AEC) industry credit-heavy and cash-poor.

Information transparency refers to the disclosure of accurate information in a clear and understandable manner (Guo et al., 2019). Transparency has three implications: disclosure, clarity, and accuracy (Schnackenberg & Tomlinson, 2014). Traditional paper-based documents make it difficult for project stakeholders to obtain and compare information, leaving room for falsification of data or information (Guo et al., 2019). Furthermore, information transparency is expected to contribute to the reduction of corruption, such as fraud, deception, dishonesty, and bribery (Bowen et al., 2007; Vee & Skitmore, 2003), by preventing unethical practices, such as overstating time and resource requirements for variation, cutting corners, and submitting false documents (Bowen et al., 2007; Stansbury & Stansbury, 2008; Vee & Skitmore, 2003).

The increasing accessibility of digitized as-built progress data, powered by robotics, building information modeling (BIM), and machine intelligence

(Bilal et al., 2016; Ham et al., 2016; Santos et al., 2017), motivates a move toward automation. However, payment automation is not yet a reality, and current payment applications neither support the use of progress data nor enable automation. Smart contracts enabled by blockchain technology have shown promise in addressing the inefficiencies of payment systems (Penzes et al., 2018); however, it is not clear what distinguishes this technology from already available means of automating payments, such as computerization of current payment applications (Hesam & Martin, 2021). Automating construction progress payments can benefit all stakeholders involved in the construction supply chain, including lenders, property owners, general contractors, subcontractors, material suppliers, and equipment rental firms, among others (Hesam & Martin, 2021). Automation can result in cost and time savings and reduce untimely payments, a major risk factor in construction (El-Sayegh, 2008) that can have severe consequences for projects, including cost overruns, delays (Assaf & Al-Hejji, 2006; Durdyev & Hosseini, 2020), and reduced trust (Manu et al., 2015). This lack of trust slows down payment processing, creating a vicious circle (Hawley, 2012; Manu et al., 2015). Although digital tools and project management software have been instrumental in addressing these issues, their adoption varies widely across the industry, and the problem persists at large.

Regulatory and Contractual Complexities:

The complexity of construction contracts, coupled with the highly regulated nature of the construction industry, further complicates payment management. Payment regulations, such as retainage practices, vary by jurisdiction and can significantly impact the cash flow of contractors and subcontractors. Although a single, standard form of contract for the construction sector has been recommended since the 1960s (Banwell, 1964), organizations continue to compete in promoting their suite of contracts (McNamara & Sepasgozar, 2018). The perceived need to customize construction contracts to suit individual projects still exists, as does the careful consideration of project-specific parameters required to execute a successful contract (Forward, 2002).

Partnering and framework agreements have faced challenges within the industry due to a deep-rooted cultural aversion to trust (Mason, 2017). It has been suggested that contracts be made trust-less (McNamara & Sepasgozar, 2018).

Moreover, the multilayered structure of construction contracts can make it challenging to determine payment responsibilities and timelines, leading to delays and disputes. The construction industry's complex structure of contracting and subcontracting sets it apart from other sectors (Empey, 2013). In the construction industry, payments flow from the owner to the main contractor and then to various subcontractors and sub-subcontractors based on satisfactory progress (Islam et al., 2017). Therefore, when any

party higher in the payment structure withholds or delays payment, the subordinate parties suffer from cash flow problems despite satisfactory work (Islam et al., 2017). In many cases, trade contractors are contractually obligated by contingent payment clauses to continue working, even when the payments owed to them have been delayed (Empey, 2013). The issue is further complicated by paid-if-paid clauses and, to a lesser extent, by paid-when-paid clauses (Islam et al., 2017).

Numerous factors contribute to late payment issues in construction projects. These include inadequate financial management by the owner, disagreements regarding the valuation of completed work leading to delayed certification, applying pay-when-paid clauses with sub-contractors, suppliers, and manufacturers, and non-adherence to contractual provisions when requesting and claiming payments (Abdul-Rahman. et al., 2006; Al-Khalil & Al-Ghafly, 1999; Arditi & Chotibhongs, 2005; Assaf Sadi. et al., 1995; Hamzah et al., 2014; Okpala Daniel & Aniekwu Anny., 1988; Ramachandra & Rotimi, 2012; Ye & Abdul, 2010). Most of these reasons are often beyond the control of contractors and other parties in the contracting chain, including sub-contractors, suppliers, and manufacturers. However, proper education and preparation can address non-compliance with contractual provisions when requesting and claiming payments.

Problem Formulation

Effective payment management is crucial to the success of construction projects. However, the current state of payment management is fraught with challenges that require a multi-faceted approach for resolution. To improve the situation, it is necessary to implement standardized payment practices and leverage technology for better transparency. Alternative dispute resolution mechanisms should also be promoted, and the regulatory framework concerning payment management improved.

The construction industry faces several issues, including delayed payments, contractual complexities, lack of transparency, and dispute resolution. These challenges require a collective effort from all stakeholders to devise and implement effective solutions. Addressing these challenges will pave the way for a more efficient, transparent, and equitable payment management system, ultimately contributing to the timely and successful completion of construction projects.

In summary, a comprehensive approach is necessary to enhance the current state of payment management in construction projects. By implementing standardized practices, leveraging technology, promoting alternative dispute resolution, and improving the regulatory framework, the construction industry can overcome the challenges it currently faces and achieve a more efficient and transparent payment management system

2. Research Methodology

This research paper conducted a comprehensive review of the existing literature to identify and evaluate relevant articles. The study's research methodology was designed with meticulous care and structured into various phases to ensure the accuracy and validity of the results.

Accurately and efficiently identify keywords

During the initial phase of this research, the primary goal was to identify pertinent keywords related to the research topic. To accomplish this, a comprehensive literature review was conducted to identify significant concepts and indicators that could be useful for the study. This preliminary search facilitated the identification of a comprehensive list of relevant keywords, which were then integrated into various keyword combinations to develop an appropriate search strategy. By following this systematic approach, the research established a strong foundation for the study, allowing it to carry out subsequent phases with a clear sense of direction and purpose.

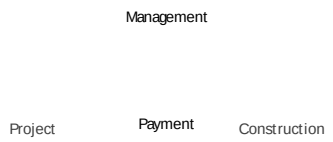

Figure 1. Keywords used in search strategies.

The illustration presented in Figure 1 provides a lucid representation of the correlation among the fundamental concepts of "Payment", "Management", "Project", and "Construction." The concepts are derived from an exhaustive analysis of the existing literature on the subject matter. The selected keywords were carefully considered and transformed into a search strategy by integrating them into a search phrase. This search strategy is anticipated to capture articles relevant to the research topic effectively.

Crafting an effective search strategy

The second phase of this research aims to devise effective search strategies to retrieve articles pertinent to the topic under investigation. The keywords identified in Figure 1 will be amalgamated in various ways to create multiple search strategies to facilitate a comprehensive search process. The objective is to identify as many relevant articles as possible. The search will be restricted to Scopus-indexed articles, given their superior quality

and accuracy in citation data compared to other sources. Scopus is an unbiased abstract and citation database maintained by eminent experts in the field. It has been selected as a pertinent international and scientific resource for this study.

Table 1. Keyword combinations per search strategy

No	Keyword combinations
1	(“payment”) and (“management”) and (“construction”)
2	(“payment”) and (“management”) and (“project”)
3	(“payment”) and (“contract”) and (“construction”)
4	(“payment”) and (“contract”) and (“project”)

Table 1 presents the outcome of the formulated search strategy, which incorporates four different search strategies to combine relevant keywords. This methodology is particularly effective in identifying pertinent articles for this research. The Publish or Perish software tool will be employed to identify relevant articles specifically designed to gather and assess citation metrics from various data sources. The software tool provides valuable insights into the number of papers, total citations, and H-index. In this case, the search using the Publish or Perish software tool will focus on searching for articles indexed by Scopus.

Identification and screening the articles

The third phase of the research process involves identifying and screening articles related to the study. These articles are subjected to meticulous scrutiny to determine their quality and suitability for the research topic. The selected articles undergo rigorous screening to meet the research requirements and criteria. The outcome of this stage is a collection of articles deemed most suitable for the study.

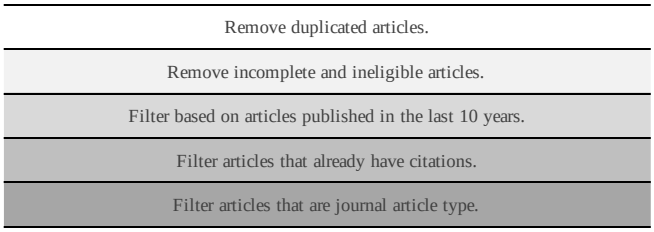

Figure 2. The procedure for identification and screening articles.

Figure 2 presents a sequential, five-stage process that has been employed to reduce the number of articles under consideration and facilitate data analysis and mapping at a later stage. The first stage involves eliminating any duplicate and incomplete/ineligible articles. The second stage consists of screening articles based on their publication period, focusing on the most recent ten years, to provide a fresh perspective and enable the study to address current issues accurately. The third stage involves screening the citations in the articles, as they indicate that other researchers and articles

have recognized and referred to the concepts, ideas, and opinions presented in the article, making them valuable contributions to the field. In addition, the articles are screened by type and will only include journal articles, not conference proceedings or statements. This ensures that the articles under consideration are scholarly publications written by researchers, professors, and other experts and that they focus on related disciplines or fields of study. The rigorous identification and filtering process is expected to ensure the quality and relevance of the article database, thereby enhancing its academic and technical value. Overall, this process ensures that the article database used in this study is of the highest quality and relevance, enabling the researcher to draw accurate and informed conclusions.

Analyze, classify, and investigate the results thoroughly

The conclusive phase of the research process involves conducting a comprehensive analysis, carefully classifying the articles, and thoroughly investigating. Quantitative and qualitative studies will be performed on the articles in question. This includes a rigorous examination and comparison of the articles, with the primary objective of identifying descriptive terms that can be classified into various aspects related to the research topic. This analysis aims to identify the elements considered to contribute to the research topic significantly. To facilitate this process, the study's results are presented in graphical form, allowing for easy comparison and interpretation. Overall, this stage is critical in providing a detailed understanding of the research topic and the various aspects that contribute to it. The classification of the articles and conducting a comprehensive investigation focuses on examining the articles deemed most relevant and will significantly contribute to the research topic. This process involves a detailed examination of the selected articles to extract valuable insights and relevant information. Ensuring that the review is comprehensive and accurate is of utmost importance. This will help provide an in-depth understanding of the research topic.

3. Results and Discussion

Quantitative analysis

Sixty articles were obtained through the implementation of four search strategies spanning the years 1975 through 2024. This study's findings provide a comprehensive overview of the literature available on the subject matter. The research offers valuable insights and knowledge to the academic and business communities interested in this field.

Table 2. Search result by keyword combination per search strategy.

No	Keyword combinations	Keyword Combinations Used	Search Result
1	Search strategy 1	(“payment”) and (“management”) and (“construction”)	11
3	Search strategy 2	(“payment”) and (“management”) and (“project”)	11
5	Search strategy 3	(“payment”) and (“contract”) and (“construction”)	32

7	Search strategy 4	(“payment”) and (“contract”) and (“project”)	6
	The Article's Total		**60**

Table 2 displays the cumulative count of articles retrieved from each keyword combination employed in the four distinct search strategies. The utilization of four keyword combinations yielded 60 articles.

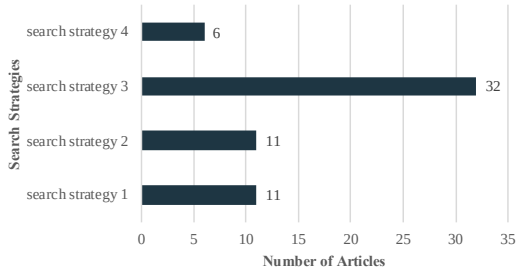

Figure 3. Search result articles by the search strategies.

The following data presents the total number of articles obtained through each search strategy, as shown in Figure 3. The results demonstrate that search strategy 3 was the most successful, generating 32 articles, accounting for approximately 53,333% of the total. Conversely, search strategy 4 produced the fewest articles, with only 6 articles, or approximately 10% of the total.

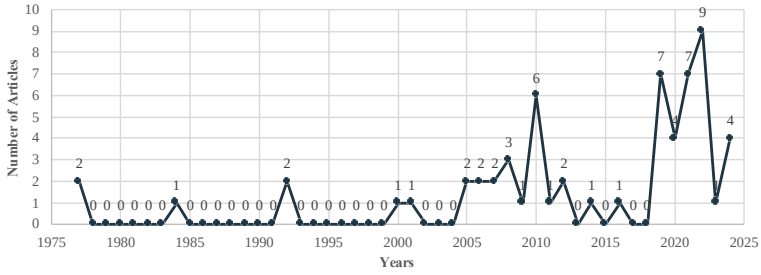

Figure 4. Search result articles by years.

The findings in Figure 4 illustrate a year-wise distribution of research articles. The fluctuations in the count of articles found each year depict the instability in the related research studies. 2022 recorded the highest number of research articles, with nine accounting for approximately 15% of the total. Conversely, some years, 1984, 2000, 2001, 2009, 2011, 2014, 2016, and 2023, had the least number of articles, with only one article each, equivalent to 1.667% of the total. Additionally, there were certain years wherein no articles were published, as depicted in Figure 2. Regarding the ongoing 2024 period, the exact number of related articles produced is uncertain as the period is still running. However, thus far, four articles have

been documented in the 2024 period.

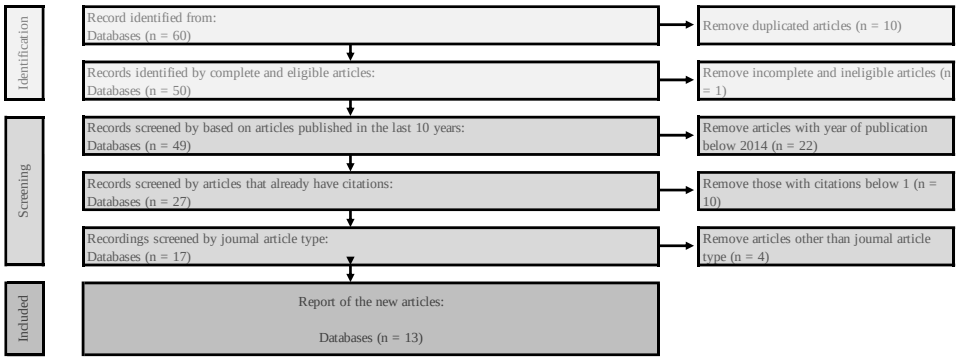

Figure 5. Data identification and screening of articles.

Figure 5 presents the process of identifying and screening all articles. Initially, 60 articles were procured, out of which only 13 satisfied the screening criteria. These 13 articles will undergo extensive analysis, classification, and investigation to extract meaningful and insightful conclusions on the research topic.

Table 3. Article results after identification and screening.

No	Search Strategies	Title	Authors	Cites	Year	Publicizer Country
1	Search strategy 1	Automated payment and contract management in the construction industry by integrating building information modeling and blockchain-based smart contracts	(Sigalov et al., 2021)	40	2021	Switzerland
2	Search strategy 1	Streamlining the management of payment delays: the case of Sri Lankan Government building construction projects	(Perera & Dewagoda, 2021)	7	2020	United Kingdom
3	Search strategy 3	A smart contract system for security of payment of construction contracts	(Ahmadisheykhsarmast & Sonmez, 2020)	115	2020	Netherlands
4	Search strategy 3	Construction payment automation using blockchain-enabled smart contracts and robotic reality capture technologies	(Hamledari & Fischer, 2021)	104	2021	Netherlands
5	Search strategy 3	Role of Blockchain-Enabled Smart Contracts in Automating Construction Progress Payments	(Hesam & Martin, 2021)	92	2021	United States
6	Search strategy 3	Blockchain and smart contracts: A solution for payment issues in construction supply chains	(Nanayakkara et al., 2021)	53	2021	Switzerland
7	Search strategy 3	BIM integrated smart contract for construction project progress payment administration	(Sonmez et al., 2022)	30	2022	Netherlands
8	Search strategy 3	Blockchain-based smart contract for smart payment in construction: A focus on the payment freezing and	(Wu et al., 2022)	13	2022	United States

		disbursement cycle				
9	Search strategy 3	Administration of Construction Contract Interim Payments Based on Earned-Value Reduction Techniques	(Demachkieh & Abdul-Malak, 2019)	4	2019	United States
10	Search strategy 3	Appropriate Types of Payments in Construction Contracts Based on Agency Theory Parameters	(Mahdi et al., 2022)	3	2022	United States
11	Search strategy 3	Reduction clause in an advance payment guarantee (AP-bond) under an overseas construction contract	(Kim, 2019)	3	2019	United Kingdom
12	Search strategy 3	Resolving power imbalances in construction payment using blockchain smart contracts	(Wu et al., 2023)	1	2023	United Kingdom
13	Search strategy 3	Side-payment contracts for prefabricated construction supply chain coordination under just-in-time purchasing	(Zeng et al., 2022)	1	2022	United Kingdom

Table 3 provides an overview of the articles identified and filtered during the study. These articles were then subjected to bibliographic mapping using the VOSviewer software based on keyword occurrence. The resulting bibliographic mapping data will be analyzed and classified to identify significant contributions and research gaps. This analysis plays a vital role in designing and formulating an effective development system to tackle this issue.

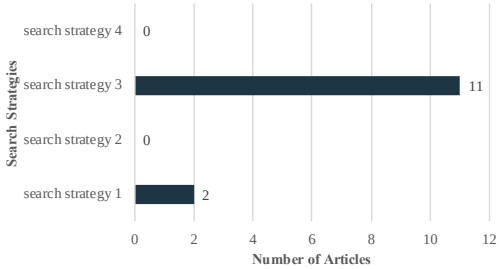

Figure 6. Identified and filtered articles by search strategies.

Figure 6 provides a comprehensive overview of the articles identified and filtered through the implemented search strategies. Amongst the four search strategies, search strategy 3 exhibited the highest efficiency, retrieving 11 articles, which accounts for approximately 84,615% of the selected articles. Search strategy 1 followed closely behind, retrieving 2 articles, constituting approximately 15,385% of the articles chosen. However, search strategies 2 and 4 did not result in any article retrieval.

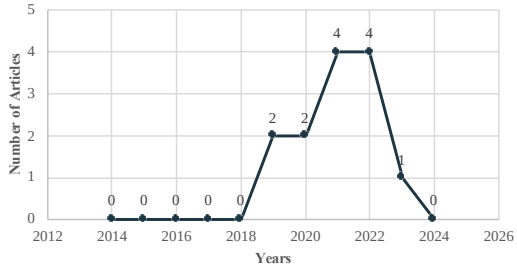

Figure 7. Identified and filtered articles by years

An overview of the selected articles, filtered by year, is presented in Figure 7. The data highlights that the years 2021 and 2022 have the highest number of articles with a total of 4 articles each, accounting for approximately 30.769% of the total selected articles. In contrast, the year 2023 has the lowest number of articles, with only 1 article, which is about 7.692% of the selected articles. Notably, no articles were found in the years 2014 to 2018 and in the current year 2024.

Figure 8. Identified and filtered articles by the number of citations

The illustration presented in Figure 8 provides a comprehensive overview of the articles procured through identification and filtering techniques based on the number of citations. Article number 3 exhibits the highest frequency of citations with a count of 115 while articles 12 and 13 have the lowest frequency with only one citation each.

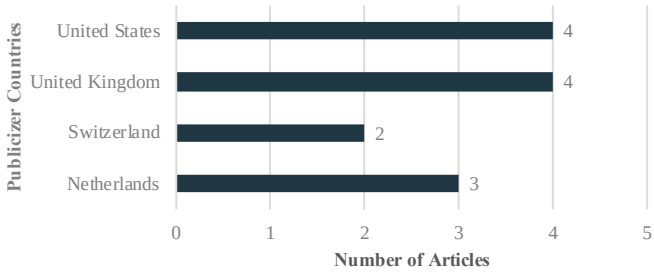

Figure 9. Identified and filtered articles by the publicizer countries.

Figure 9 presents a comprehensive overview of the articles identified and

filtered based on the country of publication. The data indicates that most articles were sourced from the United Kingdom and the United States, with each country contributing four articles. Together, they account for approximately 30.769% of all articles selected. In contrast, Switzerland contributed the least number of articles, with only 2, accounting for approximately 15.385% of all selected articles.

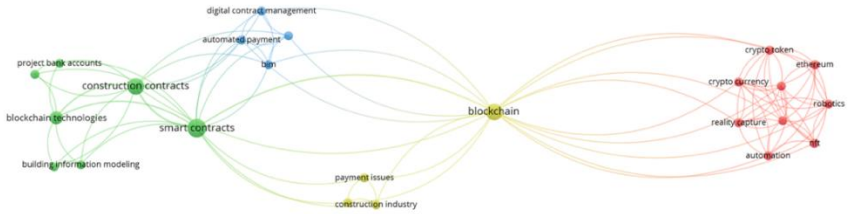

Figure 10. Network visualization of bibliographic mapping by the co-occurrence of keyword

Figure 10 illustrates the bibliographic mapping network visualization. The visualization represents each topic through circles, which vary in shape, indicating the research volume and its significant contribution. Connecting lines between the topics show their relationship and influence on each other. The colors used in the visualization represent different clusters, with different shades of the same color indicating closer relationships among the topics. Longer connecting lines indicate more distant relationships between topics, while shorter ones indicate closer relationships.

Based on the color separation, four clusters were identified. Further analysis reveals that four topics have a significant impact, with "smart contracts" being the most important topic, followed by "construction contracts", "blockchains", and "blockchain technologies". The size of the circles in Figure 10 shows the order of importance of these topics. The visual representation highlights the relationship between these topics and other topics.

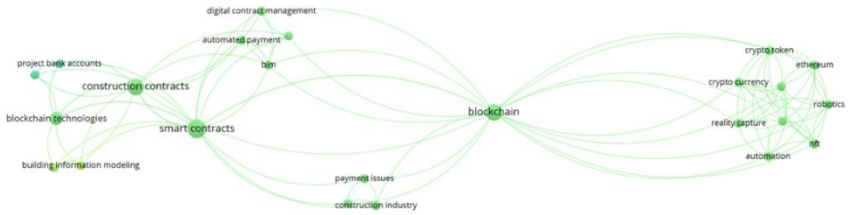

Figure 11. Overlay visualization of bibliographic mapping by the co-occurrence of keyword

The bibliographic mapping overlay's visualization is demonstrated in

Figure 11. Each topic is represented by a distinct color that signifies the novelty of the year of publication. The publications that appear lighter in color represent the more recent ones. This mapping has the potential to demonstrate the novelty of each publication in relation to the topic of study, making it highly relevant to contemporary issues. The technique presents an efficient approach to visualize and analyze bibliographic data. The mapping approach provides a clear understanding of the research landscape in a specific area and enables researchers to identify knowledge gaps in the field.

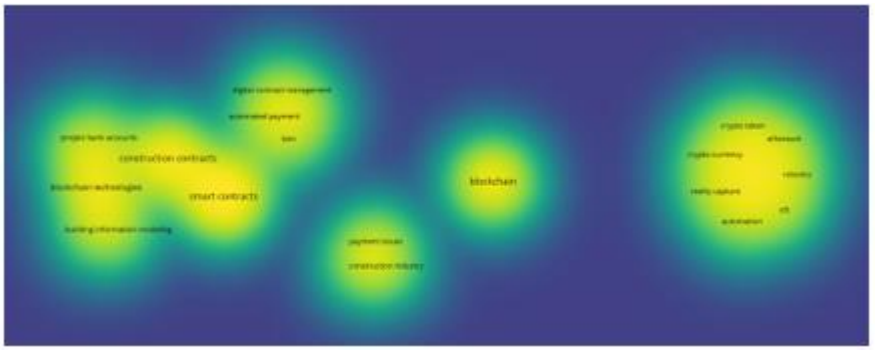

Figure 12. Density visualization of bibliographic mapping by the co-occurrence of keyword

The visualization technique of bibliographic density mapping is showcased in Figure 12. This method assigns a specific color to each topic based on its frequency of discussion, debate, and research. The bibliographic density mapping visualization approach presents a large corpus of article documents related to the research subject matter in a visual format that identifies the most prominent topics of discussion and research. This technique provides a valuable tool for analyzing and understanding complex data sets.

The visualizations of bibliographic mapping, as demonstrated in Figures 10, 11, and 12, are highly effective tools that showcase the intricate relationships and connections between various bibliographic entities, including authors, publications, and citations. These visualizations are constructed using layering techniques and incorporate color or shading to represent the density of diverse data types in a single map. They prove to be valuable in detecting areas of high research activity, bringing the impact of authors or publications to the forefront in a specific field, and illuminating patterns, trends, and clusters in bibliographic data. These maps are of immense value to researchers and academics alike, enabling them to comprehend the evolution of research topics, determine key contributions, and explore new research directions. Bibliographic mapping visualizations, with their ability to offer a comprehensive overview of vast

amounts of data, are an indispensable tool for professionals across various fields.

Qualitative analysis

A comprehensive analysis was applied to all articles obtained. This was done to get the essence of each study. From the analysis, The point that can be concluded is "Information on blockchain-based solutions for financial and payment issues in the construction industry".

The construction industry has long been struggling with financial and payment issues. However, blockchain-based smart contracts offer a promising solution. BIM-based tender documents and model-based reporting can automate payment processing, change order management, model-based reporting, and defect management.

One proposed system, the SMTSEC, is an intelligent contract-based payment security system that automates payment for construction contracts through a decentralized blockchain. This system enables timely and transparent payment processing without the administrative expenses or burdens of intermediaries such as banks or lawyers.

The proposed autonomous payment administration solution captures and analyzes construction progress using machine intelligence and BIM-based progress monitoring. The system then stores distributed progress data and broadcasts it to a smart contract that administers payments and transfers lien rights using cryptocurrencies/tokens and non-fungible tokens.

Smart contracts and blockchain technology can also enhance dispute resolution and avoidance by making a single source of truth accessible to all stakeholders. The construction industry can benefit from a blockchain-based e-procurement framework that integrates with related blockchain-based research on carbon estimating, building information modeling, construction waste management, and post-contract work and payment certification solutions.

A survey of construction professionals indicates that a BIM-integrated innovative contract progress payment administration system has significant potential for accelerating progress payments and reducing disputes, particularly for lump sum projects. Semi-autonomous BIM-integrated intelligent contract systems can potentially accelerate the adoption of BIM and innovative contract technologies in the construction sector.

Furthermore, the study analyzed the factors that influence the selection of payment types in construction contracts. The study identified critical agency parameters such as information systems, task programmability, outcome measurability, outcome uncertainty, goal conflict, and agent risk preference. It concludes that agency theory predictions can be observed in construction contracts.

Moreover, the study analyzed advance payment guarantees (AP bonds) and their legal and practical issues. The study recommends explicitly

stating the reduction clause in the guarantee, not the construction contract. It further discussed the issue of an advance payment guarantee and its relation to the required documents for reduction.

Lastly, the text covers the challenges faced by prefabricated construction supply chains (PCSCs) when adopting just-in-time purchasing (JITP). The study proposes side-payment contracts that include a delivery-time dependent subsidy and two constant transfer terms to establish a win-win outcome when initiating the operation of JITP. The results show that JITP yields higher profit for PCSC, and the proposed contracts are capable of achieving a win-win coordination.

4. Conclusion

Upon analyzing the research results, four key points emerged as essential to the appropriateness of the research topic: "smart contracts," "construction contracts," "blockchains," and "blockchain technologies." A more in-depth analysis of the selected articles indicates that the construction industry faces numerous financial and payment challenges, which can be effectively tackled by leveraging blockchain and smart contracts. These cutting-edge technologies can enhance transparency, collaboration, and automation while simultaneously improving payment administration and dispute resolution processes.

Current research endeavors are focused on developing blockchain-based frameworks and innovative contract payment systems to revolutionize the traditional payment process in construction. These studies also explore the challenges of adopting just-in-time purchasing and designing side-payment contracts that facilitate win-win coordination between construction supply chains and suppliers. One crucial factor in addressing payment-related problems in the construction industry is the development of blockchain-based smart contracts and payments.

In conclusion, this research highlights that the construction industry can significantly benefit from the adoption of blockchain and smart contracts. These advanced technologies offer a promising solution to the long-standing payment-related issues in the industry by streamlining processes and increasing efficiency.

The present study has made a significant contribution to the existing body of knowledge on payment-related issues in the construction industry. Future research can build on these findings to explore the topic further. The conclusions drawn from this research can serve as a valuable reference for authors and practitioners interested in supplementing current literature on the subject.

The research has identified several areas for future investigation. These include exploring the fundamentals of blockchain technology and smart contracts, examining the challenges faced by the construction industry in

terms of payment and financial issues, and investigating how blockchain-based smart contracts can be leveraged to address these challenges.

Furthermore, researchers could investigate the use of digital BIM-based tender documents and model-based reporting to promote collaboration, transparency, and automation. The study of intelligent contracts and blockchain technology to improve the dispute resolution and avoidance process is another area of research that deserves further attention.

Additional research could focus on the adoption of blockchain-based payment automation and the challenges associated with it, such as zero-trust computing, creating an auditable single source of truth, and smart contract security. The proposed blockchain-based e-procurement framework for construction supply chains and the BIM-integrated innovative contract progress payment administration system could also be evaluated.

Other areas for future research include the analysis of the blockchain-based intelligent contract payment system developed to address payment issues in the construction industry, the review of progress payment valuations and certifications, and the factors influencing the selection of behavior-based and outcome-based payment types in construction contracts.

The legal and practical issues related to advance payment guarantees (AP-Bonds) in the construction industry also warrant further investigation. Finally, researchers could focus on the study of a blockchain innovative contract-enabled framework to address power imbalances in construction payment and the design of side-payment contracts to effectively achieve win-win coordination between prefabricated construction supply chains (PCSCs) and suppliers adopting just-in-time purchasing (JITP).

From the above conclusions, there are several research gaps that can be identified, including specific challenges related to complex contract structures and the lack of transparency that blockchain-based smart contracts can address in the construction industry. Additionally, future research can explore how blockchain technology and smart contracts can improve progress payment valuations and certifications in the construction industry and the legal and practical issues related to advance payment guarantees (AP-Bonds) in the construction sector.

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References

1. Abdul-Rahman., H., Berawi M., A., Berawi A., R., Mohamed., O., Othman., M., & Yahya I., A. (2006). Delay Mitigation in the Malaysian Construction Industry. Journal of Construction Engineering and Management, 132(2), 125–133. https://doi.org/10.1061/(ASCE)0733-9364(2006)132:2(125)

2. Abdul-Rahman, H., Takim, R., & Min, W. S. (2009). Financial-related causes contributing to project delays. Journal of Retail & Leisure Property, 8(3), 225–238. https://doi.org/10.1057/rlp.2009.11
3. Adam, A. (2017). Aggregation of factors causing cost overruns and time delays in large public construction projects: Trends and implications. Engineering, Construction and Architectural Management, 24(3), 393–406. https://doi.org/10.1108/ECAM-09-2015-0135
4. Ahmadisheykhsarmast, S., & Sonmez, R. (2020). A smart contract system for security of payment of construction contracts. Automation in Construction, 120, 103401. https://doi.org/https://doi.org/10.1016/j.autcon.2020.103401
5. Ahmed, S. (2003). Sources of economic fluctuations in Latin America and implications for choice of exchange rate regimes. Journal of Development Economics, 72(1), 181–202. https://doi.org/https://doi.org/10.1016/S0304-3878(03)00073-7
6. Al-Khalil, M. I., & Al-Ghafly, M. A. (1999). Important causes of delay in public utility projects in Saudi Arabia. Construction Management and Economics, 17(5), 647–655. https://doi.org/10.1080/014461999371259
7. Ameer-A, & NAN. (2006). A construction industry payment and adjudication Act: Reducing payment-default and increasing dispute resolution efficiency in construction. Master Build, 4–6.
8. Arditi, D., & Chotibhongs, R. (2005). Issues in subcontracting practice. Journal of Construction Engineering and Management, 131(8), 866–876.
9. Arditi, D., Ongkasuwan, D., & Null, N. (2009). Duties and Responsibilities of Construction Managers: Perceptions of Parties Involved in Construction. Journal of Construction Engineering and Management, 135(12), 1370–1374. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000115
10. Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. International Journal of Project Management, 24(4), 349–357. https://doi.org/https://doi.org/10.1016/j.ijproman.2005.11.010
11. Assaf Sadi., A., Al-Khalil, M., & Al-Hazmi, M. (1995). Causes of Delay in Large Building Construction Projects. Journal of Management in Engineering, 11(2), 45–50. https://doi.org/10.1061/(ASCE)0742-597X(1995)11:2(45)
12. Awwad, R., Barakat, B., & Menassa, C. (2016). Understanding Dispute Resolution in the Middle East Region from Perspectives of Different Stakeholders. Journal of Management in Engineering, 32(6), 5016019. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000465
13. Banwell, H. (1964). The placing and Management of Contracts for Building and Civil Engineering Work. Construction Reports 1944, 98, 55–68.
14. Barrie, D. S., & Paulson, B. C. (1992). Professional construction management : including C.M., design-construct, and general contracting. McGraw-Hill. https://cir.nii.ac.jp/crid/1130000798296023296.bib?lang=en
15. Bilal, M., Oyedele, L. O., Qadir, J., Munir, K., Ajayi, S. O., Akinade, O. O., Owolabi, H. A., Alaka, H. A., & Pasha, M. (2016). Big Data in the construction industry: A review of present status, opportunities, and future trends. Advanced Engineering Informatics, 30(3), 500–521. https://doi.org/https://doi.org/10.1016/j.aei.2016.07.001
16. Bowen, P., Akintoye, A., Pearl, R., & Edwards, P. J. (2007). Ethical behaviour in the South African construction industry. Construction Management and Economics, 25(6), 631–648. https://doi.org/10.1080/01446190701225707
17. Brown, H., & L M, A. (1999). ADR Principles and Practice. Sweet&Maxwell, London, s 12, 15.
18. Chan, E. H. W., & Suen, H. C. H. (2005). Dispute resolution management for

international construction projects in China. Management Decision, 43(4), 589–602. https://doi.org/10.1108/00251740510593576
19. Cheng, T., Soo, G., Kumaraswamy, M., & Jin, W. (2010). Security of payment for Hong Kong construction industry. Proceedings of the Institution of Civil Engineers-Management, Procurement and Law, 163(1), 17–28.
20. Cheung, S.-O., Suen Henry C., H., & Lam, T.-I. (2002). Fundamentals of Alternative Dispute Resolution Processes in Construction. Journal of Construction Engineering and Management, 128(5), 409–417. https://doi.org/10.1061/(ASCE)0733-9364(2002)128:5(409)
21. Chin Keng, T., Ismail, A. S., & Kah Ching, Y. (2020). PRELIMARY STUDIES OF DELAYS IN CONSTRUCTION PROJECTS. Malaysian Journal of Business and Economics (MJBE), 2 SE-Article. https://doi.org/10.51200/mjbe.v0i0.2126
22. Demachkieh, F. S., & Abdul-Malak, M. A. U. (2019). Administration of Construction Contract Interim Payments Based on Earned-Value Reduction Techniques. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11(4), 4519023. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000309
23. Durdyev, S., & Hosseini, M. R. (2020). Causes of delays on construction projects: a comprehensive list. International Journal of Managing Projects in Business, 13(1), 20–46. https://doi.org/10.1108/IJMPB-09-2018-0178
24. El-Sayegh, S. M. (2008). Risk assessment and allocation in the UAE construction industry. International Journal of Project Management, 26(4), 431–438. https://doi.org/https://doi.org/10.1016/j.ijproman.2007.07.004
25. Empey, B. (2013). The need for prompt payment legislation in the construction industry. Prism Economics and Analysis, Toronto.
26. Euginie, L. (2006). Curing the ills of nonpayment in the construction industry—The Singapore experience. Proc., 8th Surveyors' Congress, Institut Sosial Malaysia (ISM), Kuala Lumpur, Malaysia.
27. Forward, F. (2002). NEC compared and contrasted with JCT 98. In The NEC compared and contrasted (pp. 1–10). Thomas Telford Publishing.
28. Gibson, A. (2004). Win for builder in court. New Zealand Herald,(Http://Www. Nzherald. Co. Nz/Business/News/).
29. Gibson, A. (2010). McKenna: Bankruptcy.
30. Guo, H., Yu, R., & Fang, Y. (2019). Analysis of negative impacts of BIM-enabled information transparency on contractors' interests. Automation in Construction, 103, 67–79. https://doi.org/https://doi.org/10.1016/j.autcon.2019.03.007
31. Gupta, P. C., & Venkataraman, K. (2010). An overview of dispute resolution procedures in road projects with reference to the FIDIC form of contract and suggestions for improvements. J. Indian Roads Congr, 71(1), 101–110.
32. Ham, Y., Han, K. K., Lin, J. J., & Golparvar-Fard, M. (2016). Visual monitoring of civil infrastructure systems via camera-equipped Unmanned Aerial Vehicles (UAVs): a review of related works. Visualization in Engineering, 4(1), 1. https://doi.org/10.1186/s40327-015-0029-z
33. Hamledari, H., & Fischer, M. (2021). Construction payment automation using blockchain-enabled smart contracts and robotic reality capture technologies. Automation in Construction, 132, 103926. https://doi.org/https://doi.org/10.1016/j.autcon.2021.103926
34. Hamzah, A.-R., Meiye, K., & Chen, W. (2014). Late Payment and Nonpayment Encountered by Contracting Firms in a Fast-Developing Economy. Journal of Professional Issues in Engineering Education and Practice, 140(2), 4013013. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000189
35. Harmon Kathleen M., J. (2003). Resolution of Construction Disputes: A Review

of Current Methodologies. Leadership and Management in Engineering, 3(4), 187–201. https://doi.org/10.1061/(ASCE)1532-6748(2003)3:4(187)
36. Haugen, T., & Singh, A. (2015). Dispute Resolution Strategy Selection. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 7(3), 5014004. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000160
37. Hawley, K. (2012). Trust: A very short introduction. OUP Oxford.
38. Hesam, H., & Martin, F. (2021). Role of Blockchain-Enabled Smart Contracts in Automating Construction Progress Payments. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 13(1), 4520038. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000442
39. Islam, E., Salwa, F., Hunter, B., & Noor, A. (2017). Studying Payment Provisions under National and International Standard Forms of Contracts. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 9(2), 4516011. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000200
40. Jagannathan, M., & Delhi Venkata Santosh, K. (2019). Litigation Proneness of Dispute Resolution Clauses in Construction Contracts. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11(3), 4519011. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000301
41. Jagannathan, M., & Delhi Venkata Santosh, K. (2020). Litigation in Construction Contracts: Literature Review. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 12(1), 3119001. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000342
42. Jagannathan, M., Quapp, U., & Delhi Venkata Santosh, K. (2021). Litigation Risk Transfer Mechanisms in Construction Dispute Resolution Process: Cross-Case Analysis. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 13(3), 4521018. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000486
43. Jeffrey Boon Hui, Y., Pei Ling, G., Yoke Bee, W., & Martin, S. (2021). Revisiting critical delay factors for construction: Analysing projects in Malaysia. Alexandria Engineering Journal, 60(1), 1717–1729. https://doi.org/https://doi.org/10.1016/j.aej.2020.11.021
44. Kaplan, N., Spruce, J., & Cheng, T. Y. W. (1991). Hong Kong arbitration: cases and materials. (No Title).
45. Kartam, N. A., & Kartam, S. A. (2001). Risk and its management in the Kuwaiti construction industry: a contractors' perspective. International Journal of Project Management, 19(6), 325–335. https://doi.org/https://doi.org/10.1016/S0263-7863(00)00014-4
46. Kennedy., P. (2006). Progress of Statutory Adjudication as a Means of Resolving Disputes in Construction in the United Kingdom. Journal of Professional Issues in Engineering Education and Practice, 132(3), 236–247. https://doi.org/10.1061/(ASCE)1052-3928(2006)132:3(236)
47. Kim, S. M. (2019). Reduction clause in an advance payment guarantee (AP-bond) under an overseas construction contract. Journal of Korea Trade, 23(1), 35–49.
48. Kumaraswamy, M. M. (1997). Conflicts, claims and disputes in construction. Engineering Construction and Architectural Management, 4(2), 95–111. https://doi.org/https://doi.org/10.1046/j.1365-232X.1997.00087.x
49. Liu, J., Li, H., Skitmore, M., & Zhang, Y. (2019). Experience mining based on case-based reasoning for dispute settlement of international construction projects. Automation in Construction, 97, 181–191. https://doi.org/https://doi.org/10.1016/j.autcon.2018.11.006
50. Mahdi, H. S., Mohammad, A., & G., C. D. (2022). Appropriate Types of Payments in Construction Contracts Based on Agency Theory Parameters. Journal of

Construction Engineering and Management, 148(1), 4021187. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002228

51. Manu, E., Ankrah, N., Chinyio, E., & Proverbs, D. (2015). Trust influencing factors in main contractor and subcontractor relationships during projects. International Journal of Project Management, 33(7), 1495–1508. https://doi.org/https://doi.org/10.1016/j.ijproman.2015.06.006
52. Mason, J. (2017). Intelligent Contracts and the Construction Industry. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 9(3), 4517012. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000233
53. McGeorge, D., London, K., Love, P., Davis, P., Jefferies, M., Ward, P., & Chesworth, B. (2007). Dispute avoidance and resolution a literature review. CRC for Construction Innovation Rep, 1.
54. McNamara, A., & Sepasgozar, S. (2018). Barriers and drivers of Intelligent Contract implementation in construction. Management, 143, 2517006.
55. Mikhail Carol., A., & Serag, E. (2019). Quantifying the Delay from Lost Productivity. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 11(4), 5019005. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000322
56. Muller, C., & Ward, M. (2013). Style-based effects on the Johannesburg Stock Exchange: A graphical time-series approach. Investment Analysts Journal, 42(77), 1–16. https://doi.org/10.1080/10293523.2013.11082552
57. Nanayakkara, S., Perera, S., Senaratne, S., Weerasuriya, G. T., & Bandara, H. M. (2021). Blockchain and Smart Contracts: A Solution for Payment Issues in Construction Supply Chains. In Informatics (Vol. 8, Issue 2). https://doi.org/10.3390/informatics8020036
58. Navon., R. (1996). Company-Level Cash-Flow Management. Journal of Construction Engineering and Management, 122(1), 22–29. https://doi.org/10.1061/(ASCE)0733-9364(1996)122:1(22)
59. Ng Helen., S., Peña-Mora, F., & Tamaki, T. (2007). Dynamic Conflict Management in Large-Scale Design and Construction Projects. Journal of Management in Engineering, 23(2), 52–66. https://doi.org/10.1061/(ASCE)0742-597X(2007)23:2(52)
60. Odeyinka, H. A., & Kaka, A. (2005). An evaluation of contractors' satisfaction with payment terms influencing construction cash flow. Journal of Financial Management of Property and Construction, 10(3), 171–180. https://doi.org/10.1108/13664380580001074
61. Odeyinka, H. A., Lowe, J., & Kaka, A. (2008). An evaluation of risk factors impacting construction cash flow forecast. Journal of Financial Management of Property and Construction, 13(1), 5–17. https://doi.org/10.1108/13664380810882048
62. Okpala Daniel, C., & Aniekwu Anny., N. (1988). Causes of High Costs of Construction in Nigeria. Journal of Construction Engineering and Management, 114(2), 233–244. https://doi.org/10.1061/(ASCE)0733-9364(1988)114:2(233)
63. Penzes, B., KirNup, A., Gage, C., Dravai, T., & Colmer, M. (2018). Blockchain technology in the construction industry: Digital transformation for high productivity. Institution of Civil Engineers (ICE), 55.
64. Perera, B. A. K. S., & Dewagoda, K. G. (2021). Streamlining the management of payment delays: the case of Sri Lankan Government building construction projects. Journal of Financial Management of Property and Construction, 26(2), 236–256. https://doi.org/10.1108/JFMPC-05-2020-0041
65. Peters, E., Subar, K., & Martin, H. (2019). Late Payment and Nonpayment within the Construction Industry: Causes, Effects, and Solutions. Journal of Legal Affairs

and Dispute Resolution in Engineering and Construction, 11(3), 4519013. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000314

66. Ramachandra, T., & Rotimi, J. O. (2011). The Nature of Payment Problems in the New Zealand Construction Industry. The Australasian Journal of Construction Economics and Building, 11(2), [22]-33. https://search.informit.org/doi/10.3316/informit.145146141525264
67. Ramachandra, T., & Rotimi, J. O. B. (2012). Construction payment delays and losses: Perceptions of New Zealand.
68. Ramachandra, T., & Rotimi James Olabode, B. (2015). Mitigating Payment Problems in the Construction Industry through Analysis of Construction Payment Disputes. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 7(1), A4514005. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000156
69. Rosenberg, J. D., & Folberg, H. J. (1993). Alternative dispute resolution: An empirical analysis. Stan. L. Rev., 46, 1487.
70. Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. International Journal of Project Management, 25(5), 517–526. https://doi.org/https://doi.org/10.1016/j.ijproman.2006.11.007
71. Santos, R., Costa, A. A., & Grilo, A. (2017). Bibliometric analysis and review of Building Information Modelling literature published between 2005 and 2015. Automation in Construction, 80, 118–136. https://doi.org/https://doi.org/10.1016/j.autcon.2017.03.005
72. Schnackenberg, A. K., & Tomlinson, E. C. (2014). Organizational Transparency: A New Perspective on Managing Trust in Organization-Stakeholder Relationships. Journal of Management, 42(7), 1784–1810. https://doi.org/10.1177/0149206314525202
73. Semple, C., Hartman Francis., T., & Jergeas, G. (1994). Construction Claims and Disputes: Causes and Cost/Time Overruns. Journal of Construction Engineering and Management, 120(4), 785–795. https://doi.org/10.1061/(ASCE)0733-9364(1994)120:4(785)
74. Sigalov, K., Ye, X., König, M., Hagedorn, P., Blum, F., Severin, B., Hettmer, M., Hückinghaus, P., Wölkerling, J., & Groß, D. (2021). Automated Payment and Contract Management in the Construction Industry by Integrating Building Information Modeling and Blockchain-Based Smart Contracts. In Applied Sciences (Vol. 11, Issue 16). https://doi.org/10.3390/app11167653
75. Sonmez, R., Ahmadisheykhsarmast, S., & Güngör, A. A. (2022). BIM integrated smart contract for construction project progress payment administration. Automation in Construction, 139, 104294. https://doi.org/https://doi.org/10.1016/j.autcon.2022.104294
76. Stansbury, C., & Stansbury, N. (2008). Examples of corruption in infrastructure. Global Infrastructure Anti-Corruption Centre⟨ Http://Www. Giaccentre. Org/Documents/GIACC. CORRUPTIONEXAMPLES. Pdf⟩(Feb. 25, 2017).
77. Stipanowich, T. J. (2004). ADR and the "Vanishing Trial": The Growth and Impact of "Alternative Dispute Resolution." Journal of Empirical Legal Studies, 1(3), 843–912. https://doi.org/https://doi.org/10.1111/j.1740-1461.2004.00025.x
78. Torchia, M., & Calabrò, A. (2018). Increasing the Governance Standards of Public-Private Partnerships in Healthcare. Evidence from Italy. Public Organization Review, 18(1), 93–110. https://doi.org/10.1007/s11115-016-0363-1
79. Tran, H., & Carmichael, D. G. (2012). Contractor's financial estimation based on owner payment histories. Organization, Technology & Management in Construction: An International Journal, 4(2), 481–489.
80. Treacy Thomas., B. (1995). Use of Alternative Dispute Resolution in the

Construction Industry. Journal of Management in Engineering, 11(1), 58–63. https://doi.org/10.1061/(ASCE)0742-597X(1995)11:1(58)

81. Vee, C., & Skitmore, Cm. (2003). Professional ethics in the construction industry. Engineering, Construction and Architectural Management, 10(2), 117–127. https://doi.org/10.1108/09699980310466596
82. Wideman, R. M., & Eng, P. (1990). Construction claims identification, communication and record keeping. A Paper Presented to a TUNS/Revay Seminar.
83. Wu, L., Lu, W., & Chen, C. (2023). Resolving power imbalances in construction payment using blockchain smart contracts. Engineering, Construction and Architectural Management, ahead-of-p(ahead-of-print). https://doi.org/10.1108/ECAM-03-2023-0194
84. Wu, L., Lu, W., & Xu, J. (2022). Blockchain-based smart contract for smart payment in construction: A focus on the payment freezing and disbursement cycle. Frontiers of Engineering Management, 9(2), 177–195. https://doi.org/10.1007/s42524-021-0184-y
85. Ye, K., & Abdul, H. R. (2010). Risk of late payment in the Malaysian construction industry (pp. 81–89).
86. Zeng, L., Du, Q., Zhou, L., Wang, X., Zhu, H., & Bai, L. (2022). Side-payment contracts for prefabricated construction supply chain coordination under just-in-time purchasing. Journal of Cleaner Production, 379, 134830. https://doi.org/https://doi.org/10.1016/j.jclepro.2022.134830