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Project management innovations in construction:

with a focus on Project Bank Accounts

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EXECUTIVE SUMMARY

Persistent late payments and the withholding of retentions are well-documented problems in construction supply chains. These practices erode working capital—especially for Small Medium Enterprises (SMEs)—exacerbate insolvency risk and negatively affect the health and well-being of the workforce. Sponsored by the Save Construction Initiative (SCI), this research report evaluates whether Project Bank Accounts (PBAs)—supported where appropriate by digital solutions such as Digital Parallel Payment Accounts (DiPPAs)—can materially improve payment timeliness, transparency, and security across projects.

PBAs are positioned here as an early-stage project management (PM) innovation. Several governments and public clients have provided guidance and, in some cases, mandated PBAs on qualifying works. However, adoption remains uneven and real-world experience shows PBAs are not, by themselves, a guarantee against undesirable payment practices. Accordingly, this study adopts a learning-from-adjacent-innovations approach: it examines the evidence base on established PM innovations in construction (e.g., Building Information Modelling (BIM); green/sustainable construction practices; and gamification) and distils transferable lessons to inform robust design and implementation blueprints for PBAs.

A Systematic Literature Review (SLR) following PRISMA 2020 was conducted. From 80 identified records (Scopus, Web of Science, ProQuest Central), 47 were screened after de-duplication and 22 outputs were included for synthesis. Fifteen outputs addressed PM innovations broadly and 7 focused directly on PBAs. These 7 were supplemented by 2 academic papers with partial PBA coverage. Data extraction and thematic analysis were organised around five areas: the innovation landscape; impacts; issues; enablers/critical success factors (CSFs); and used management theories.

Key Findings

1) Innovation landscape and exemplars.

PM innovation in construction spans organizational/process changes (e.g., collaborative innovation ecosystems), technological platforms (BIM as a strategic management innovation), behavioural techniques (gamification for safety and engagement), and sustainability agendas (green/eco-innovation). Innovations are generative and implementational: they must be conceived and then embedded via collaborative practices, contracts, workflows, and governance.

2) Impacts on organisations, projects, individuals.

Reported benefits include improved safety, quality, productivity, and employee engagement (gamification), enhanced information interoperability and dispute reduction (BIM), and environmental gains (green buildings). At the project level, collaborative innovation correlates with better sustainability outcomes and efficiencies; at the individual level, innovations can raise motivation, job satisfaction, and well-being.

3) Issues and barriers.

Contractual complexity (e.g., interoperability obligations and role clarity in BIM), cultural resistance (reluctance to enforce overdue payment charges due to commercial pressures), data governance (immutability and change-order handling in blockchain), and legislative limitations (weak sanctions and inconsistent adoption of government guidance) constrain diffusion. These challenges emphasise that technology alone cannot reform payment culture; behavioural and institutional mechanisms are equally vital.

4) Critical success factors (CSFs).

Success consistently hinges on collaborative working, stakeholder buy-in, and network roles (gatekeeper, coordinator, champion). Professionalism and ethics matter, particularly in procurement and digital transactions; standardised processes mitigate fragmentation and enhance interoperability; and a strategic fit between innovation and organisational goals is essential to deliver commercial impact. The industry context—marked by power imbalances between clients, main contractors, and subcontractors—must be addressed to shift norms (e.g., chronic late payments).

5) Evidence base on PBAs.

The PBA literature is nascent, with limited empirical case studies and a concentration of conceptual and proof-of-concept work exploring blockchain-hosted PBAs. These studies suggest that PBAs and associated solutions, such as DIPPAs and smart contracts , can automate payments, reduce administrative workload, democratise access to funds across supply tiers, accelerate account setup, and improve traceability and auditability of cash flow. However, barriers persist, including system fragmentation and lack of integration with proprietary tools, regulatory immaturity surrounding smart contracts, and perceived or actual cost burdens, especially for main contractors and SMEs attempting to self-administer payment controls.

Recommendations

Recommendations for industry practitioners, policy makers and academic/research funders involved/interested in the design and implementation of PBAs are as follows:

- *For industry practitioners:*

Run controlled pilots of PBAs within public or large private projects, targeting representative supply chains and measuring payment latency, administrative effort, dispute incidence, and cash-flow granularity against baseline methods. Include independent risk assurance roles (technical and financial) where appropriate and adopt an Integrated Project Team approach to align behaviours and responsibilities.

Integrate and standardise processes: map existing workflows (cash-flow scheduling, supply chain approvals, invoice validation) and embed standardised information-exchange protocols to reduce interoperability risks. Develop and implement standard operating procedures and guidelines.

Strengthen governance and culture: formalise role clarity (gatekeeper, coordinator, champion) in innovation networks; implement open-book practices and transparent

performance reporting; and train project participants in ethical procurement and digital payment controls to reduce opportunism.

- *For policy makers:*

Update and align guidance across jurisdictions, clarifying when PBAs are required, minimum features, data standards, and reporting obligations. Pair guidance with enforceable regulation for persistent late payment and unethical practices and consider mandating PBAs above defined thresholds in public contracts to build an empirical base and market capability.

- *For academia and research funders:*

Conduct longitudinal, comparative studies focused on PBA proof of concept and on quantifying the cost-effectiveness of PBAs versus traditional payment systems, capturing outcomes such as payment delay distributions, working capital impacts, insolvency rates, and administrative overheads. Complement quantitative work with qualitative network analyses to understand diffusion dynamics. Pursue mixed-methods evaluations of interoperability solutions, focusing on socio-technical integration (people, process, structure and technology) and developing replicable toolkits i.e. route maps, templates, role profiles, training modules, that practitioners can adopt. Utilise theories like network science and social learning theory to understand how innovations associated with the introduction of PBAs can be diffused in the construction industry.

Conclusions

The SLR shows that PBAs—especially when augmented by digital automation—have the potential to deliver real improvements in payment timeliness, transparency, and administrative efficiency, strengthening liquidity and trust across construction supply chains. However, PBAs are not a standalone fix. Desirable outcomes depend on collaborative governance, standardised and interoperable processes, professional ethics, and supportive regulation capable of overcoming entrenched cultural and structural barriers.

Short term pilots and longitudinal studies can generate the empirical evidence required to move from conceptualisation of PBAs to mainstream adoption. Lessons from more mature and embedded PM innovations, such as BIM, green/sustainable construction and gamification show that success lies in the fusion of initiatives and practices that focus on people, process, structure and technology. In short, the pathway to widespread PBA adoption is a socio-technical journey. With strategic leadership, disciplined implementation, and evidence informed policy and practice, PBAs and complementary digital solutions like DiPPAs can evolve from early-stage innovations into core payment infrastructure for construction—advancing both industry performance, including a healthier workforce, and academic understanding of how complex innovations diffuse and endure

1 INTRODUCTION

In this section of the report, we introduce the background, context and motivation to the study, the aim and research questions, the research method, scope of the study and structure of the report.

1.1 Background, context and motivation

The study is sponsored by the Save Construction Initiative (SCI) [1]. A key aim of the SCI is to improve the business models and working practices prevalent in the construction industry. These models and practices often lead to high levels of insolvency for companies in the sector and poor health and well-being outcomes for individuals who work in the sector.

One issue the SCI wish to address is the late payments culture. A proposed solution is the use of Project Bank Accounts (PBAs) and various national and state governments have provided guidance on their use and, in some cases, in their role as Clients of public sector-funded projects, mandated their use on construction works that meet specific criteria[2]. Alongside the promotion of PBAs is the emergence of digital solutions to ensure that payments to members of the supply chain are transparent, timely and secure, which is a fundamental requirement of an efficient and effective PBA. An example of such a solution is a Digital Parallel Processing Account (DiPPA) [3].

Given the relative newness of PBAs, they are an example of an early-stage innovation, with the focus to date being on the development of the PBA concept, proof-of-concept of associated digital solutions and the processes and procedures required to translate PBAs from concept to practical reality. As with all early-stage innovations, the potential exists for PBAs to make a significant difference to the late payments problem in the construction sector, yet such an innovation, whilst having high rewards, also comes with high risk.

Recent media reports of the use of a PBA, shows that their adoption are no guarantee that undesirable practices relating to the control and distribution of money by clients, main contractors and companies further downstream in the supply chain will be eliminated[4]. This suggests that the risks relating to PBAs fall into two broad categories: 1) flaws in the concept/design of the PBA 2) an absence of the conditions of success required for the implementation of a conceptually sound and robustly designed PBA.

To mitigate these risks, and given the newness of PBAs, with the associated lack of an evidence base relating to their implementation, it would be useful to refer to prior research

[1] https://saveconstruction.uk/ - Save Construction Initiative Website
[2] Examples are: UK PBA Guidance and Process [note – its initial 2022 guidance is now out of date and has been withdrawn, with a replacement being prepared] - [Withdrawn] Project bank accounts - GOV.UK; Scotland - Construction projects: Project Bank Accounts (PBAs) - gov.scot; Wales - Welsh Procurement Policy Note (WPPN) 010: Project bank accounts [HTML] | GOV.WALES; Western Australia - Project-Bank-Account-Guideline-for-Contractors.pdf
[3] DiPPAs How the UK's SME Plan Will Impact Construction Businesses: A Timely Innovation for Saible's DiPPA - Save Construction Initiative
[4] MoJ owes us £20m after contractor ISG's collapse, say suppliers - BBC News

on introducing other innovations relating to the management of projects in the construction industry. By learning lessons from other innovations, we hope that the first steps towards developing a blueprint for the successful adoption of PBAs can be taken.

1.2 Aim and Research Questions

Hence, the overall aim of this study is to analyse the body of knowledge on previously implemented project management (PM) innovations in the construction industry. This analysis will provide a foundational evidence base, which can inform the development of blueprints, as to how PBAs can be successfully integrated into the business practices used to manage projects in the construction industry. In addition, we seek to review the current body of knowledge on PBAs. To achieve this aim, we developed five research questions (RQs), which are:

- RQ1 – What are example PM innovations that provide useful lessons for the design and implementation of PBAs?
- RQ2 – What are the enablers and barriers to the adoption of these innovations?
- RQ3 – What evidence is there on the relative cost-effectiveness of these innovations?
- RQ4 – What management (and related) theories contribute to an understanding of the impact of these innovations?
- RQ5 – What is the evidence base on the design and implementation of PBAs?

1.3 Method

The body of knowledge on PBAs and other PM innovations in the construction industry will be analysed through a Systematic Literature Review (SLR). An SLR is a structured and systematic approach to identifying, selecting, evaluating, and synthesizing academic and associated work. Our approach follows the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidelines [5]. PRISMA provides a process for reporting why a systematic review was carried out, what methods were used, and what results were found.

Our search strategy is to primarily focus, where possible, on peer-reviewed academic papers in reputable journals, as indicated by The Chartered Association of Business Schools (CABS) 2024 edition of the Academic Journal Guide (AJG 2024), which comprises 1,822 journals[6] and the citation databases in the Institute for Scientific Information (ISI) Web of Science[7]. In addition to the Web of Science, other databases to be searched are Scopus, including Emerald Insight and Science Direct and ProQuest Central, including ABI/INFORM. Additional grey literature, such as reports, government documents, white papers, doctoral dissertations, will be sourced, especially concerning PBSs, where limited academic journal papers are anticipated.

[5] PRISMA Website PRISMA statement
[6] AJG 2024 Academic Journal Guide | Chartered Association of Business Schools
[7] Web of Science by Clarivate

The inclusion criterion is outputs published since 2020, and non-English language sources are excluded.

The data from the results of each selected source will be recorded inz a defined extraction excel spreadsheet. The results will be synthesised narratively and then interpreted. A PRISMA Flow Diagram will be produced providing quantitative data on the identification, screening and inclusion of sources. The data to be extracted in relation to each output is as follows: reference (in Harvard referencing format[8]); ranking/rating of source (if academic journal), search term; abstract (if applicable); type of output, type of academic journal (if applicable i.e. conceptual, empirical study; aim/objective; method(s); findings; relevance to review; additional notes. The data will be analysed thematically,

1.4 Scope of the Research

The study takes the premise that PBAs are a PM innovation and, due to them being newly adopted in the industry and, hence, there being limited literature on their implementation, in addition to PBAs, we seek to learn lessons and extrapolate findings from the literature relating to other PM innovations introduced into the construction sector. Hence, the scope of our study is on PM innovations, in general, and PBAs, in particular, with the empirical context of the construction industry.

1.5 Structure of the Report

The report is structured as follows: in the next section (2) we present the Results of the PRISMA process, including a discussion of the number and characteristics of the outputs identified through the SLR. The next two sections contain the details of the thematic analysis relating to, firstly, PM innovations (Section 3) and, secondly, PBAs (Section 4). Section 5 draws from the data presented in sections 3 and 4 to derive enablers and barriers to the effective design and implementation of PBAs. Recommendations for industry practitioners, policy makers, and academia and research funders are outlined in Section 6. Conclusions are drawn in Section 7 and the report ends with a list of references to the outputs in the SLR (section 8) and, finally, in Section 9, the Appendices, which comprise of details of the SLR search terms and output details.

[8] Harvard reference guidance Quick guide to Harvard referencing (Cite Them Right) | Library Services | Open University

2 RESULTS

The PRISMA Flow Diagram below illustrates the results of identifying, screening, and including sources for the SLR. In the Identification stage, using key word searches linked to the 5 research questions, 80 outputs were sourced: 49 in Scopus, 8 in Web of Science and 23 in ProQuest Central. The Screening stage led to the removal of 33 records that contained duplicates of outputs, resulting in 47 outputs assessed for their eligibility. In the final Inclusion stage 25 outputs were removed, due the topic not being appropriate, the output not being in a suitable form, or the focus of the output not being on the construction industry. This resulted in 22 papers being selected for the review.

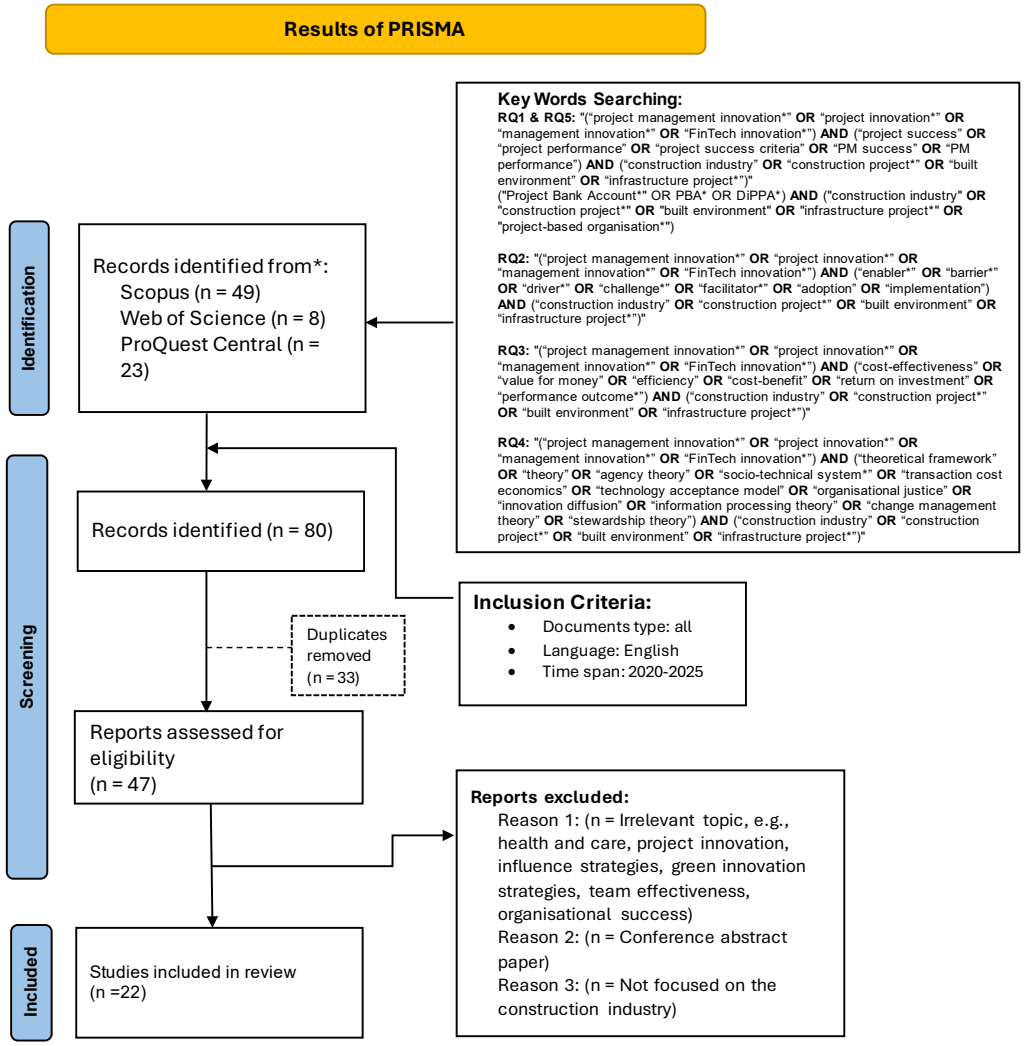

Fig 1: PRISMA Flow Diagram

[Adapted from - Research Methods & Reporting, The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71 doi: https://doi.org/10.1136/bmj.n71 (Published 29 March 2021)]

In relation to RQs 1-4[9], the SLR comprises of 15 outputs, all of which were papers published in peer-review academic journals [see Outputs 1-15 in Appendix 2]. This reflects the relative maturity of the topic in terms of academic enquiry. Of these 15, 4 involved empirical study of a real-life PM innovation. The innovations were BIM [2 outputs – numbers 1 and 4 in Appendix 2] and green/sustainable construction [2 outputs – numbers 3 and 9]. The fact that both BIM and green/sustainable construction are not examples of early-stage innovations, having been relatively long-established in practice, means that the lag between adoption in practice and subsequent empirical study in the field is not an issue. There was also one empirical study of Late Payments, in the form of a survey of sub-contractors [Output 11]. The remaining 10 papers reported conceptual research/thinking/perceptions on the processes and structures of innovation, such as collaborative innovation, innovation eco-systems and smart contract payment security systems.

For RQ5[10] the SLR identified 7 outputs whose primary focus was on PBAs [Outputs 16-22 in Appendix 2]. In addition, Outputs 13 and 14, did refer to PBAs, though this was one small part of each paper, so they were included in the thematic analysis reported in section 3 of this report. Of the 7 PBA-focused outputs, 5 are inter-linked, being first authored by Scott, who published their Doctoral Thesis containing a proof of concept of a PBA blockchain payment application for the construction industry in 2025 [Output 16]. Prior to this, they published, with co-authors, a book chapter [Output 17], a full paper for a conference [Output 18] and 2 papers for peer-reviewed academic journals [Outputs 19 and 20]. Whilst much of the work reported in these 5 outputs is conceptual by nature, they do propose a PBA blockchain application and test its hypothesis through proof of concept. Data were also collected from construction consultants with working experience of PBAs to validate the conceptual work.

The final two outputs on PBAs [Outputs 21 and 22] comprised of a) a trade journal opinion piece, which examined the UK government's efforts to help address the construction industry's issues with late payment and retentions and highlighted the successful use of PBAs in Scotland and Wales, and b) a trade journal editorial which critiqued the UK government's position on PBAs, which has been criticized for its inconsistency.

Overall, the lack of empirical study, to date, of cases in which PBAs have been used on construction projects, reflects the fact that they are a relatively recent innovation within the industry. As is the case with BIM, green/sustainable construction – and other innovations that are more embedded in PM practices – one would hope to see empirical studies in peer-reviewed academic journals emerging, as PBAs are increasingly adopted on construction projects.

[9] RQs1-4: What are example PM innovations that provide useful lessons for the design and implementation of PBAs? What are the enablers and barriers to the adoption of these innovations? What evidence is there on the relative cost-effectiveness of these innovations? What management (and related) theories contribute to an understanding of the impact of these innovations?

[10] RQ5 – What is the evidence base on the design and implementation of PBAs?

3. PROJECT MANAGEMENT INNOVATIONS – THEMES

The thematic analysis of project management (PM) innovations was structured around 5 pre-defined areas: 1) The Innovation Landscape, 2) The Impacts of Innovation, 3) Issues, 4) Enablers/Critical Success Factors and 5) Theories.

From the data, 3 sub-themes were identified relating to The Innovation Landscape, which were 1) Definitions of, 2) Examples of, and the 3) Process of. In the area of The Impacts of innovation, another 3 sub-themes identified were: 1) On organisations, 2) On projects and 3) On Individuals. Four sub-themes relating to Issues were: 1) Contractual, 2) Data Management, 3) Legal and 4) Legislative. The sub-themes of 1) Collaborative Working, 2) Industry Context, 3) Professionalism, 4) Resources, 5) Roles, 6) Stakeholders, 7) Standardised processes and 8) Strategic approach emerged in Critical Success Factors. Finally, in relation to Theories, 2 sub-themes were identified: 1) Network Science and 2) Social Learning Theory.

The remainder of this chapter presents the data in each of the sub-themes for the 5 areas.

2.1 The Innovation Landscape

2.1.1 Definitions of

In the literature reviewed, an explicit link is made between PM innovation and "management" or "organisation" innovation, which, regardless of the terminology used, "emphasizes innovations in organizational structure and management processes" and is "an implementation of radically new products, processes, and management approaches" [Output 9 – see Appendix 2].

Note - whilst the definition above explicitly states that innovation is radical, there is other literature, not included in this review, which also describes a non-radical form of innovation, classed as "incremental", which is about refining and improving existing products, processes, and management approaches. PM innovations can be either radical or incremental.

Regardless of whether it is classed as radical or incremental, for a change in the PM arena to be innovative, it needs to be consequential, such as furthering organisational goals [Output 2] and different from anything done before i.e. "a *nontrivial* change and improvement in a process, product, or system that is *novel* to the institution developing the change [Output 3]. Hence it is a departure from traditional management techniques that alters how management performs work and furthermore, it changes how [PM] managers do what they do [Output 2]. The latter point emphasises that PM innovations typically result in behavioural change.

Finally, definitions of innovation highlight a two-staged process, being about "the *generation* and *implementation* of management practice, process, structure, or technique that is new to the state of the art…" [Output 2]. A successful innovation requires effective management of both stages.

2.1.2 Examples of

Whilst there are many PM practices, processes, structures, or techniques that meet the definition of an innovation, as set out in the previous section, three examples were explicitly described in the literature as innovations in the construction industry. They are: 1) Building Information Modelling (BIM) [Output 1], 2) Gamification [8], and 3) Green/Sustainable Building/Construction [Output 3], [9].

These examples demonstrate the range of consequences of innovation. In the case of BIM, it is a "strategic management innovation" [Output 1]. Gamification, which is the process of using game design elements and techniques in non-game contexts, enhances "enhances employee engagement, motivation and performance … to motivate and engage individuals" [Output 8]. Green/Sustainable Building/Construction has "a positive impact on the environment" [3] and builds ''… a healthy living environment" [Output 9].

An holistic and comprehensive description of an example of an innovation in construction is neatly encapsulated in one paper:

> "Green innovation, also known as sustainable innovation or eco-innovation, refers to the development and application of new ideas, technologies, products, processes, and business models that have a positive impact on the environment and promote sustainability" [Output 3].

The paper on green innovation also refers to the two-stage process of innovation, stating that "Green Building projects qualify as a case of "innovation" [generation/development], as well as a case of "diffusion of innovation" [implementation/application] [Output 9]. A long-standing viewpoint in the literature is that case studies of trajectories of innovation are required to identify who generates new ideas and how they are managed into "good currency" [Output 4].

2.1.3 Process of

The literature emphasises that the process of managing an innovation is as important as the innovation development process itself [Output 4]. In this respect, construction is a project-based activity and firms involved in the sector need to manage the innovation process across organizational boundaries [Output 9]. Hence, the process is one typically characterised as involving collaborative innovation, which is defined as "… a reciprocal process whereby two or more individuals or organizations work together to share resources and knowledge in order to reap the maximum benefits for all" [Output 10]. Collaborative innovation includes two dimensions: integration and interaction, with, ideally, a mutually beneficial "… cascade effect of information transmission, communication, and mutual learning through interaction and acceptance of information regarding the innovation decision-making behaviors of other organizations" [Output 10].

The notion of collaborative innovation links to another conception that applies to the landscape in which project-focused firms in the construction industry operate, namely: "innovation eco-systems". These systems "integrate the innovations of individual firms into a coherent, customer-oriented set of solutions with synergistic effects [Output 6].

Whilst potentially offering much to firms, the literature offers a note of caution on innovation ecosystems:

> "The innovation ecosystem is not naturally equipped with the ability to generate synergistic effects, and the acquisition of synergistic effects such as sharing R&D costs, dispersing innovation risks, and enhancing core competencies are only the psychological expectations of the cooperating parties and how to transform this expectation into reality is an unavoidable issue of the governance of the innovation ecosystem pitfalls" [Output 6]

Arguably, an easier to implement approach sees individual innovations as part of a wider system, whereby there are inter-relationships between each innovation. For example, one innovation, gamification, is used to promote another innovation, BIM, adoption and improve the effectiveness of BIM implementation in construction [Output 8].

2.2 The Impacts of Innovation

2.2.1 On organisations

There can be a very focused organisational impact from an innovation. For example, gamification is seen to impact on safety "…[games] foster a culture of safety in the workplace, where workers are encouraged to prioritize safety and look out for one another…" [Output 8]. Yet in this same study, several additional impacts are evidenced i.e. quality, PM, innovation and productivity and workforce development.

2.2.2 On projects

Literature reporting a study of the infrastructure business sector reports that collaborative innovation was pursuant to achieving sustainability and efficiency in construction projects [Output 10].

2.2.3 On individuals

Besides having organisational impact, an innovation can also impact on individuals. Beyond contributing to safety, as described in section 2.2.1, by incorporating game-like elements into safety training and protocols, construction organizations can improve worker engagement and motivation to follow safety procedures. This enhanced engagement and motivation can improve job satisfaction and attract more skilled workers to the industry. It [games] can encourage construction workers to stay physically fit by creating fitness challenges, which can be utilized to promote mental health support, ultimately contributing to a better quality of life for construction workers and the communities they serve [Output 8].

2.3 Issues

2.3.1 Contractual

Contractual issues can be viewed from two perspectives: firstly, technical issues and secondly, behavioural issues. From a technical perspective the example of BIM innovations highlights the presence of contractual challenges in the context of interoperability, where interoperability is the exchange and management of data. Two solutions are proposed: including protocols for ensuring interoperability in the contract or, if not included as part of

the contracts, then taking additional steps through the design of the PM system to ensure that all project team members follow the BIM plan [Output 1]. From a behavioural perspective there is evidence that, regardless of the robustness of the contract or the PM system, there might be external forces at play that lead people to behave in ways not expected. For example, in the case of chasing up late payment, a study found that "… subcontractors are reluctant to negotiate or enforce such contractual provisions [charges for overdue payments] due to competitiveness in the market and commercial concerns" [Output 11].

2.3.2 Data management

As highlighted in the previous section, interoperability is identified as an issue, in relation to other examples of innovation. For example, focus groups and workshops seeking insights into blockchain implementation in construction highlighted issues relating to establishing mechanisms allowing modification of the immutable data [in a blockchain], such as any payment changes, change orders, or penalties [Output 12]. In the case of the development of an innovative project procurement model, the issue of balancing interoperability and integration requirements is highlighted. Creating a bi-dimensional structure necessitates conceptual and operational relationships between these two elements and the resolution of conceptual and practical integration and interoperability is a challenge that needs overcoming [Output 13].

2.3.3 Legal

A study into the introduction of BIM highlights the need to consider legal aspects when devising BIM contracts [Output 1].

2.3.4 Legislative

Legislative measures are a commonly used method to resolve issues that innovations also seek to address. For example, in the UK a review of legislation put in place to address late payment issues is set out, with a view that such legislation is not effective in changing management practices in the construction industry [Output 11].

2.4 Critical Success Factors (CSFs)

The literature reports studies aimed to investigate the Critical Success Factors (CSFs) for research driven construction management innovations [Output 5]. The prominent ones are highlighted below.

2.4.1 Collaborative working

A study of the potential of innovative models for construction procurement to counter costs overruns in construction projects highlights the importance of collaborative working as a CSF [Output 14]. This is consistent with the earlier point about the applicability of collaborative innovation as an appropriate process.

2.4.2 Industry context

The section on contracts above highlights how, when a new innovation is being implemented, behaviours are sometimes not as expected, with a reason for this being the industry context, specifically the characteristics and culture of the industry i.e. contractors being reluctant to negotiate or enforce such contractual provisions due to the highly

competitive nature of the sector, with the accompanying fear of loss of business [Output 12]. So, the character and culture of the inter-organisational environment in which an innovation is implemented is a key CSF [Output 12].

This point is articulated in one study, in relation to resolving the problem of late payments:

> "… the power imbalance between main contractors and subcontractors… clients, contractors, and consultants have different views about which party is responsible for disputes in construction. Similar differences may exist between the views of the main contractors and the subcontractors when it comes to payment practice…a culture change may be needed if this norm [late payments] is to be changed" [Output 11]

2.4.3 Professionalism

An analysis of CSFs affecting the implementation of blockchain innovations in construction highlights how "service providers, suppliers, and contractors in particular are concerned with the structure of electronic auction systems that are prone to unethical behaviour" [Output 14]. This highlights the importance of ethical behaviour and professionalism. This point is also made in relation to introducing BIM-related innovations:

> "It [the success of the innovation] will depend largely on the professionalism and integrity of the Professional Architects alongside the responsibility of the contractor to perform their duties with due care and diligence" [Output 1].

2.4.4 Resources

The need to pay attention to key individuals, as an essential resource in the project team network, to prevent the loss of key personnel during collaborative innovation is highlighted as a CSF in a study of implementing sustainable construction initiatives [Output 9].

2.4.5 Roles

A people-focused CSF is the roles people play. Three ideal role types are proposed: gatekeeper, coordinator, and champion, in the collaborative innovation network, with these roles being filled by individuals who occupy appropriate positions in the project network [Output 9]. Additionally, part of addressing contractual issues, discussed above, is by outlining the roles of project participants at the functional level, in terms of innovation implementation, rather than placing the emphasis solely on the technology [Output 1].

2.4.6 Stakeholders

In project-oriented sectors, like construction, inter-organizational collaboration is a CSF to successful innovation, and such collaboration requires the engagement, involvement and expertise of multiple stakeholders. Yet inter-organizational cooperation is a major barrier to innovation in construction [Output 9].

This collaboration process is "… characterized by the resource amalgamation of cross-organization stakeholders, which entails a systematic optimization process, rather than a simple accumulation of innovation resources among stakeholders at various levels [Output 10]. It requires the buy-in of key stakeholders and decision-makers, such as employers and

high-level executives. The stakeholders will fulfil key roles in the innovation management process, such as gatekeeper, coordinator and champion. High-level executives will lead the way in promoting the adoption of an innovation and, crucially, in creating a culture of innovation that supports the integration of new initiatives into the project network [Output 8].

This innovation management process is not without its challenges. The difficulty in driving changes comes from the divergent interests of the numerous stakeholders with diverse motivations. As articulated in a case study of industrial construction project networks:

> "Especially, construction projects contain multiple participants and stakeholders, and the knowledge, technologies, and materials are dispersed among different organizations. It hinders the implementation of new technology or products through mutual distrust, poor communication and time and cost limits. These barriers to the adoption of innovation are particularly severe when considering the use of sustainable technologies or processes, typically characterized as high cost, high risk and low availability of information" [Output 9].

2.4.7 Standardised processes

A CSF that mitigates the risk of a lack of, or ineffective, inter-organisational collaboration, as outlined in the previous section, is standardised processes. For example, as recognised in relation to introducing BIM, standardized information exchange processes facilitate consistency and help avoid misunderstanding or miscommunication (which would, in turn, lead to disputes). Using standard processes promotes uniformity, facilitates collaboration, and reduces interoperability issues [Output 1].

2.4.8 Strategic approach

A final CSF relates to having a strategic approach to the development and implementation of an innovation. Success in leveraging gamification to enhance productivity and employee engagement in the construction industry was, in part, attributed to "… aligning gamification strategies with organizational goals and values". In this way the innovation achieves its goal and, ultimately, contributes to economic and commercial impact [Output 8].

2.5 Theories

2.5.1 Network Science

Network science theories explain and explore how collaborative innovations are cascaded down through the various companies involved in construction projects. This is done through the application of Social Network Analysis (SNA), which studies interactions between actors in a project network and the evolution of their relationships [Output 10]. In the example of sustainable construction initiatives, SNA provides insights into the collaboration patterns of innovation. These insights enable those responsible for innovations to strengthen relationships where required, to increase network connectivity; and to build better bridge positions, to encourage inter-organizational technology interaction, so there is increased diversity of knowledge [Output 9].

2.5.2 Social Learning Theory

Social learning theory posits that when one observes the behaviours of others and notices the positive side, one is likely to imitate those behaviours. So, after observation of cooperative behaviour, for example in effective collaborative innovation, various mechanisms, including innate mimicry, trigger the transmission of those behaviors across social network connections in sequence to others not involved in the original interaction [Output 10].

4 PROJECT BANK ACCOUNTS

Four themes were identified in relation to the [albeit limited] literature on PBAs. These were: 1) Problems addressed, 2) Adoption of, 3) Alternatives/complimentary to, 4) Features and 5) Barriers to adoption. Within the last of these themes, three sub-themes identified were: 1) Systems fragmentation, 2) Regulatory and 3) Costs.

Data illustrating each of these themes and sub-themes are presented in this chapter.

a. Problems addressed

The literature identifies two main problems that PBAs address. Firstly, late timely payments. As articulated in a study of multiple projects, including a survey of subcontractor's' experiences "… late payment remains a significant concern in the construction industry … subcontractors are the ones most subjected to late payment. It is a key source of disputes between subcontractors and main contractors" [Output 11].

Secondly, the release of retentions: "... a key concern for subcontractors is that the holding of retention is not used for its intended purpose. It is reported that main contractors hold onto retention to improve their cash flow to the subcontractors' detriment… the most significant contributor to insolvencies in the construction industry is holding retention monies longer than the justified period". In its role of Client, the UK government states that "… one method to combat the ongoing retention issues would be [PBAs] enabling SMEs working in government projects to receive payment in 5 days or less from the due date [Output 11].

b. Adoption of

There is guidance in the literature on some of the structures and roles required for the adoption of a PBA. For example, the link between establishing an Integrated Project Team approach as a precursor to setting up a PBA is made. Within this approach a recommendation is to initiate Integrated Project Insurance and establish the roles of a Technical Independent Risk Assurance and Financial Independent Risk Assurance, which are novated to the insurer [within the selected PBA option] [Output 14].

c. Alternatives, complimentary to

There is a recognition that the payment culture of the construction industry cannot be changed by technology alone and hence, various initiatives containing various legal, contractual, and administrative solutions to mitigate or prevent payment issues, besides PBAs, are suggested. One initiative is to enhance the robustness of administrative strategies i.e. "…proper record keeping to early invoicing and potentially capitalizing on initiatives such as the use of contract management software" [Output 11].

Another is the use of performance-related bonds, which can be adopted to help prevent the misuse of retention. However, for subcontractors, using a retention bond instead of retention monies requires an agreement from the main contractor. Pre-eminent in terms of alternative/complimentary technical solutions proposed is blockchain and smart contract

technologies, which offer "… the potential to speed up payments due to enhanced transparency need for accountability and reduced red tape" [Output 11].

d. Features

Much of the literature to-date on PBAs is conceptual in nature, with a particular focus on utilising blockchain technology. It is argued that the values of PBA and blockchain harmonise across several key attributes such as transparency, auditability, and disintermediation. For example, a proposed PBA blockchain model provides a high-level overview of how project participants could interact with a blockchain application to upload payment activities, validate works, and automate the execution of liabilities to the supply chain. In the model, to mitigate the risk of non-payment from the client, tokenised collateral is used as a medium of exchange with a bank, thereby allowing the bank to automate the execution of overdue payments in exchange for collateral [Outputs 16-20].

e. Barriers to adoption

i. Systems fragmentation/integration

The first barrier, identified in the current literature, to the adoption of a PBA is systems fragmentation or a lack of integration: "… the main barriers to its adoption [PBA Blockchain framework] are a… lack of interoperability with existing proprietary systems" [Output 18].

ii. Regulatory maturity

The second barrier identified is a lack of regulatory maturity [Output 18].

iii. Costs

The third identified barrier is costs. The first issue in relation to costs is one of perceptions:

> "Main contractors tend to avoid their implementation as they are seen as costly and administratively cumbersome, increasing overheads and reducing profit" [Output 11]

The second issue is the experiences of some subcontractors who have tried to tackle payment issues using alternatives to a PBA, as described in section 4.3 above:

> "Administratively, some subcontractors have been found to employ more staff to try and prevent the payment issues from occurring, creating new job roles to help monitor payments and other accounting information, primarily monitoring payment amounts and dates… although this method proves to be productive, SMEs cannot afford to do this due to the additional costs involved, which poses a problem for smaller companies" [Output 11].

These experiences feed the perception that attempts by sub-contractors/SMEs, on their part, to address late payment and retention issues, whether that be through participation in projects utilising a PBA, or other methods, are too costly to implement.

5 BARRIERS/ENABLERS TO PBAS

The PM/PBA themes in the previous 2 chapters show PM as a socio-technical system (STS). STS is an approach to work design that acknowledges the interaction between people and technology in organisations. STS theory considers both the social elements of people and society and the technical aspects of organizational structure and processes[11]. Taking a STS approach the enablers and barriers to the effective use of PBAs are shown in Fig 2 below.

Barriers and Enablers to effective use of Project Bank Accounts

ENABLERS

- **PEOPLE**
  - Professionalism - ethical behaviours
  - Active innovation management roles - gatekeeper, coordinator, champion
  - Stakeholder buy-in, engagement, involvement, expertize, collaboration
  - Strong leadership from high-level executives
  - Observed effective innovations
- **PROCESS**
  - Collaborative innovation and ways of working together
  - Understood and communicated innovation management process
  - Existing inter-organisational technology interactions
  - Strategic approach, aligned to goals/values
- **STRUCTURE**
  - Innovation eco-systems
  - Resource amalgamation across organisations
- **TECHNOLOGY**
  - Robust data infrastructure
  - Existence of digital solutions to support PBA concepts i.e. payments and flows of monies
  - Alternative and complementary solutions i.e. blockchains, smart contracts

BARRIERS

- **PEOPLE**
  - Resistance to change
  - Unhelpful behaviours driven by industry characteristics, contractual landscape, culture
  - Loss of key personnel
  - Lack of buy-in from decision-makers and other key stakeholders
  - Absence of leadership in creating a culture of innovation
  - Multiple participants with diverse and competing motivations
- **PROCESS**
  - Absence of standardised processes
  - Lack of effective inter-organisational communication methods
  - Absence of methods for knowledge exchange
- **STRUCTURAL**
  - Dominant business models
  - Competitive nature of industry
  - Low organisational resilience, high failure rates and fear of loss of business
  - Time and cost limits on projects
  - Mutual mistrust
  - Low levels of regulatory maturity
  - Legal concerns, including data privacy and data ownership issues
  - Skills/capabilities gaps
- **TECHNOLOGY**
  - Dispersed technologies
  - Low levels of interoperability and data exchange/management
  - Immaturity in adoption of technologies
  - Systems fragmentation
  - Perceived and actual costs of innovation

Fig 2: Barriers and Enablers to effective use of Project Bank Accounts

[11] What is Socio-Technical Systems (STS)? Systems Thinking Alliance Socio-Technical Systems (STS) - Systems Thinking Alliance

6 RECOMMENDATIONS

Recommendations for industry practitioners, policy makers and academic/research funders involved/interested in the design and implementation of PBAs are set out below.

- *For industry practitioners:*

Run controlled pilots of PBAs within public or large private projects, targeting representative supply chains and measuring payment latency, administrative effort, dispute incidence, and cash-flow granularity against baseline methods. Include independent risk assurance roles (technical and financial) where appropriate and adopt an Integrated Project Team approach to align behaviours and responsibilities.

Integrate and standardise processes: map existing workflows (cash-flow scheduling, supply chain approvals, invoice validation) and embed standardised information-exchange protocols to reduce interoperability risks. Develop and implement standard operating procedures and guidelines.

Strengthen governance and culture: formalise role clarity (gatekeeper, coordinator, champion) in innovation networks; implement open-book practices and transparent performance reporting; and train project participants in ethical procurement and digital payment controls to reduce opportunism.

- *For policy makers:*

Update and align guidance across jurisdictions, clarifying when PBAs are required, minimum features, data standards, and reporting obligations. Pair guidance with enforceable regulation for persistent late payment and unethical practices and consider mandating PBAs above defined thresholds in public contracts to build an empirical base and market capability.

- *For academia and research funders:*

Conduct longitudinal, comparative studies focused on PBA proof of concept and on quantifying the cost-effectiveness of PBAs versus traditional payment systems, capturing outcomes such as payment delay distributions, working capital impacts, insolvency rates, and administrative overheads. Complement quantitative work with qualitative network analyses to understand diffusion dynamics. Pursue mixed-methods evaluations of interoperability solutions, focusing on socio-technical integration (people, process, structure and technology) and developing replicable toolkits i.e. route maps, templates, role profiles, training modules, that practitioners can adopt. Utilise theories like network science and social learning theory to understand how innovations associated with the introduction of PBAs can be diffused in the construction industry.

7 CONCLUSIONS

In this study we set out to examine the potential of PBAs as an innovation to address persistent payment issues in the construction industry, particularly late payments and retention practices that undermine financial stability and supply chain resilience. Through a SLR of 22 outputs, we explored lessons from other PM innovations—such as BIM, gamification and green/sustainable construction - to inform strategies for successful PBA adoption.

The findings confirm that PBAs represent an early-stage innovation with significant promise but also considerable implementation challenges. While PBAs can enhance transparency, accelerate payment cycles, and reduce disputes, their effectiveness depends on more than technical deployment. The review highlights that socio-technical factors—people, processes, structures, and technology—must align to create conditions for success. Collaborative working, stakeholder engagement, and strong leadership emerged as critical enablers, alongside standardized processes and strategic alignment with organizational goals. Conversely, cultural resistance, fragmented systems, regulatory immaturity, and perceived cost burdens remain major barriers.

Evidence from blockchain-based proof-of-concept studies suggests that digital solutions can strengthen PBAs by automating payment flows, improving auditability, and reducing administrative overheads. These technologies offer opportunities to democratize access to funds across supply tiers and enhance trust through immutable records. However, their adoption introduces new challenges, including interoperability with legacy systems, legal uncertainties, and the need for regulatory frameworks to legitimize digital solutions. The industry's competitive nature and entrenched behaviors—such as reluctance to enforce contractual provisions—further complicate diffusion.

Lessons from other PM innovations reinforce that successful adoption requires a holistic approach. BIM and green/sustainable construction initiatives demonstrate the importance of integrating technical solutions with contractual clarity, professional ethics, and cultural change. Gamification illustrates how behavioural strategies can complement technological interventions to drive engagement and compliance. Theories such as network science and social learning provide valuable lenses for understanding how innovations cascade through project networks and how cooperative behaviors can be amplified.

Ultimately, PBAs and complementary digital solutions, like DiPPAs, have the potential to transform payment practices and improve project outcomes, but this transformation will not occur organically. It requires strategic planning followed by execution at the operational level and the buy-in and participation of the various companies in the supply chain that require payment for their products and services. In addition, study of pilot projects and the collection of longitudinal data can generate empirical evidence on the cost effectiveness of PBAs, regulatory reforms can mandate or incentivize adoption, and capacity-building initiatives can equip stakeholders with the skills and tools required for implementation, and academic-industry collaboration can co-produce replicable frameworks, evaluate cost-effectiveness, and disseminate best practices.

Returning to the initial research questions, table 1 below provides summary answers to each one.

Research Questions – with summary answers

Research Question	Answer
RQ1 – What are example PM innovations that provide useful lessons for the design and implementation of PBAs?	Building Information Modelling (BIM), green/sustainable construction, gamification, blockchain and smart contracts. These example innovations illustrate lessons for PBA design and implementation in such areas as: interoperability, collaboration, strategic alignment, and automation.
RQ2 – What are the enablers and barriers to the adoption of these innovations?	Key Enablers include collaborative working, stakeholder buy-in, leadership, standardized processes, and robust technology infrastructure and supporting digital processes. Major barriers are cultural resistance, fragmented systems, regulatory immaturity, legal concerns, perceived and actual costs.
RQ3 – What evidence is there on the relative cost-effectiveness of these innovations?	There is limited empirical evidence to date. Conceptual research on PBAs suggests potential savings i.e. via automation and reduced admin workload.
RQ4 – What management (and related) theories contribute to an understanding of the impact of these innovations?	The following 3 theories are potential theoretical lenses for future research: 1) Socio-Technical Systems (STS) theory (design and implementation of PBAs considers people, process, structural and technological issues), 2) Network Science theory (diffusion of PBAs through project networks), 3) Social Learning Theory (adoption of PBAs through observation).
RQ5 – What is the evidence base on the design and implementation of PBAs?	Nascent and mostly conceptual; proof-of-concept i.e. blockchain enabled PBA applications, that show promise for automation and transparency. The trade literature highlights inconsistent adoption of PBAs, to date, and policy gaps

Table 1: Summary answers to Research Questions

To conclude, PBAs, with associated digital solutions for payment flows etc, should be viewed not as a standalone technical fix but as part of a broader innovation ecosystem that integrates technology, governance, and culture. By embracing a socio-technical-systems perspective and leveraging insights from prior innovations, the construction industry can move toward a more equitable, efficient, and resilient payment environment—one that safeguards members of the supply chain, enhances trust, and supports sustainable project delivery. The journey from PBA concept to mainstream adoption will require persistence,

collaboration, and strategic leadership, but the potential rewards—in terms of financial stability of companies, especially the SMEs in the supply chain, stakeholder confidence, positive impacts on project performance, enhanced health and well-being of individuals who work in the construction, and, industry reputation and attractiveness as a sector to work in, justify the effort.

8 REFERENCES

Abd Jamil, A.H. and Fathi, M.S. (2020) Enhancing BIM-Based Information Interoperability: Dispute Resolution from Legal and Contractual Perspectives. Journal of Construction Engineering and Management, 146 (7) 05020007.

Aftab, J., Sarwar, H., Abid, N., Ishaq, M.I., Kiran, A. and Aftab, F. (2022) The Nexus of Management Innovation, Performance Management, and Organizational Performance in the Pakistani Construction Industry. Central European Management Journal, 30 (4), 2-26.

Ahmad, T. (2023) Innovation in Green Building Projects: An Exploratory Inquiry. Buildings, 13 (9).

Ahmadisheykhsarmast, S., & Sonmez, R. (2020) A smart contract system for security of payment of construction contracts. Automation in construction, 120, 103401.

Bolton, S., Wedawatta, G., Wanigarathna, N., & Malalgoda, C. (2022) Late payment to subcontractors in the construction industry. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 14(4), 04522018.

Collinge, W.H. (2024) Advancing social practice understandings of digital innovation delivery in construction project management. Engineering, Construction and Architectural Management.

Hadiwattege, C., Senaratne, S., Sandanayake, Y.G. and Fernando, N. (2022) Merging Academic Research and Industry Requirements for Innovative Construction Management Practices in Sri Lanka: A Study on Critical Success Factors. International Journal of Construction Education and Research, 18 (1), 32-48.

He, C. and Liu, X. (2024) A Study on Corporate Management Strategies for Downstream Innovation Ecosystems in the Context of Digital Economy. Applied Mathematics and Nonlinear Sciences, 9 (1).

Ing, W. (2023) Has the government WASHED its HANDS? Construction News, 40-43. Retrieved from https://www.proquest.com/trade-journals/has-government-washed-hands/docview/3069281656/se-2

Liu, H., Ju, Q., Zhao, N., Li, H. and Skibniewski, M.J. (2022) Value Proposition for Enabling Construction Project Innovation by Applying Building Information Modeling. Computational Intelligence and Neuroscience, 2022.

Marrs, C. (2023) No regulatory help in sight as suppliers shoulder the cost of firms' failures. Construction News, , 3. Retrieved from https://www.proquest.com/trade-journals/no-regulatory-help-sight-as-suppliers-shoulder/docview/3068163376/se-2

Oke, A.E., Aliu, J., Mwanaumo, E.M.M., Abayomi, T. and Kahanji, C. (2023) Leveraging gamification to enhance productivity and employee engagement in the Nigerian construction industry. Built Environment Project and Asset Management, 13 (6), 813-829.

Scott, D. J. (2025) A proof of concept of a project bank account (PBA) blockchain payment application for the construction industry (Doctoral dissertation, UCL (University College London)).

Scott, D., & Broyd, T. (2024) Investigating hosting project bank accounts (PBAs) on the blockchain and its potential value contribution to the UK construction industry. Journal of Information Technology in Construction (ITcon), 29(41), 935-975.

Scott, D., Ma, L., & Broyd, T. (2024) Project bank account (PBA) decentralised application for the construction industry. Construction Innovation.

Scott, D. J., Broyd, T., & Ma, L. (2022) Conceptual model utilizing blockchain to automate project bank account (PBA) payments in the construction industry. In Blockchain for Construction (pp. 141-165). Singapore: Springer Nature Singapore.

Scott, D., Broyd, T., & Ma, L. (2022) Conceptual framework of a Project Bank Account (PBA) blockchain payment application for the construction industry. In EC3 Conference 2022 (Vol. 3, pp. 0-0). European Council on Computing in Construction.

Sheamar, S., Wedawatta, G., Tennakoon, M., Palliyaguru, R., & Antwi-Afari, M. (2024) The potential of new models of construction procurement to counter cost overruns in construction projects: An exploratory study from a contractors' perspective. Journal of Financial Management of Property and Construction, 29(2), 211-228. doi:https://doi.org/10.1108/JFMPC-08-2022-0035

Tezel, A., Febrero, P., Papadonikolaki, E., & Yitmen, I. (2021). Insights into blockchain implementation in construction: models for supply chain management. Journal of management in engineering, 37(4), 04021038.

Yazicioglu, E., & Kanoglu, A. (2022) A project procurement model enabling competition by design concept by integrating performance-based assessment (PBA), process-based estimating (PBE), and cost network modeling (CNM) tools. International Journal of Construction Supply Chain Management, 12(2), 65-92.

Zhang, R., Wang, Z., Tang, Y. and Zhang, Y. (2020) Collaborative Innovation for Sustainable Construction: The Case of an Industrial Construction Project Network. IEEE Access, 8, 41403-41417.

Zhang, R., Xue, X. and Zhang, Y. (2021) The cascade effect of collaborative innovation in infrastructure project networks. Journal of Civil Engineering and Management, 27 (3), 175-187.

9 APPENDICES

1. **Search Terms**
2. **Details of Outputs**

Appendix 1: Search Terms

RQ1&RQ5 – What are example PM innovations that provide useful lessons for the design and implementation of PBAs? RQ5 – What is the evidence base on the design and implementation of PBAs?

- (“management innovation(s)” **OR** “project innovation(s)” **OR** “project management innovations” **OR** “FINTECH innovations”) **AND** (“project success” **OR** “project success criteria” **OR** “PM success” **OR** “PM performance” **OR** “PM success criteria”) "(“project management innovation*” **OR** “project innovation*” **OR** “management innovation*” **OR** “FinTech innovation*”) **AND** (“project success” **OR** “project performance” **OR** “project success criteria” **OR** “PM success” **OR** “PM performance”) **AND** (“construction industry” **OR** “construction project*” **OR** “built environment” **OR** “infrastructure project*”)"
- ("Project Bank Account*" **OR** PBA* **OR** DiPPA*) **AND** ("construction industry" **OR** "construction project*" **OR** "built environment" **OR** "infrastructure project*" **OR** "project-based organisation*")

RQ2 – What are the enablers and barriers to the adoption of these innovations?

- "(“project management innovation*” **OR** “project innovation*” **OR** “management innovation*” **OR** “FinTech innovation*”) **AND** (“enabler*” **OR** “barrier*” **OR** “driver*” **OR** “challenge*” **OR** “facilitator*” **OR** “adoption” **OR** “implementation”) **AND** (“construction industry” **OR** “construction project*” **OR** “built environment” **OR** “infrastructure project*”)"

RQ3 – What evidence is there on the relative cost-effectiveness of these innovations?

- "(“project management innovation*” **OR** “project innovation*” **OR** “management innovation*” **OR** “FinTech innovation*”) **AND** (“cost-effectiveness” **OR** “value for money” **OR** “efficiency” **OR** “cost-benefit” **OR** “return on investment” **OR** “performance outcome*”) **AND** (“construction industry” **OR** “construction project*” **OR** “built environment” **OR** “infrastructure project*”)"

RQ4 – What management (and related) theories contribute to an understanding of the impact of these innovations?

- (“project management innovation*” **OR** “project innovation*” **OR** “management innovation*” **OR** “FinTech innovation*”) **AND** (“theoretical framework” **OR** “theory” **OR** “agency theory” **OR** “socio-technical system*” **OR** “transaction cost economics” **OR** “technology acceptance model” **OR** “organisational justice” **OR** “innovation diffusion” **OR** “information processing theory” **OR** “change management theory” **OR** “stewardship theory”) **AND** (“construction industry” **OR** “construction project*” OR “built environment” OR “infrastructure project*”)"

Appendix 2: Details of Outputs

Output	Output Reference	Type of Output	Relevant Findings
1	Abd Jamil, A.H. and Fathi, M.S. (2020) Enhancing BIM-Based Information Interoperability: Dispute Resolution from Legal and Contractual Perspectives. Journal of Construction Engineering and Management, 146 (7), 05020007.	Academic Journal Paper	Data were collected from a case study, including interviews with 8 project stakeholders. Respondents described BIM as a new strategic management innovation, and they discussed the need to consider legal aspects when devising BIM contracts. Building information modelling (BIM) produces positive results for the construction delivery process. BIM obtains these types of results by enabling information interoperability in respect of a building or facility throughout its life cycle phases and dealing with contractual challenges for BIM-based construction projects.
2	Aftab, J., Sarwar, H., Abid, N., Ishaq, M.I., Kiran, A. and Aftab, F. (2022) The Nexus of Management Innovation, Performance Management, and Organizational Performance in the Pakistani Construction Industry. Central European Management Journal, 30 (4), 2-26.	Academic Journal Paper	Data were collected through a survey-based method from 281 managerial-rank employees working in the construction industry of Pakistan. The results reveal that management innovation and performance management directly influence organizational performance
3	Ahmad, T. (2023) Innovation in Green Building Projects: An Exploratory Inquiry. Buildings, 13, 2359.	Academic Journal Paper	To address the socio-environmental challenges of the built environment, Green Buildings (GB) projects need to continuously innovate. Semi-structured interviews with 45 GB experts from six regions were conducted. The study identified some factors contributing to innovation in GBs: support from the government, client, and project team; availability of time and budget; scalability of innovative solutions; and nature of the construction industry.
4	Collinge, W.H. (2024) Advancing social practice understandings of digital innovation delivery in construction project management. Engineering, Construction and Architectural Management, 32 (7), 4611-4630	Academic Journal Paper	Applies social practice theory to clarify the process of innovation design and delivery from one successful digital innovation: the building information modelling (BIM) risk library. Applies Schatzki's "organisation of practice" concepts to clarify how the practice of innovation revolves around understandings, rules and "teleoaffectivities" (emotive behaviours). Clarifies how collective understandings and rules of use evolve over time, becoming formalised into contracts, agreements and workplans, whereby innovation "sayings" evolve into innovation "doings".
5	Hadiwattege, C., Senaratne, S., Sandanayake, Y.G. and Fernando, N. (2022) Merging Academic Research and Industry Requirements for Innovative Construction Management Practices in Sri Lanka: A Study on Critical Success Factors. International Journal of Construction Education and Research, 18 (1), 32-48	Academic Journal Paper	To lead the construction industry toward innovations through research-informed management practices requires strong academic-industry assimilation. The perspectives of academia and industry were obtained through questionnaires and explored through semi-structured interviews. The research confirms the academic research's potential to foster innovations in construction management practices if initiated inside "the innovation space", executed properly, and disseminated strategically.

Output	Output Reference	Type of Output	Relevant Findings
6	He, C. and Liu, X. (2024) A Study on Corporate Management Strategies for Downstream Innovation Ecosystems in the Context of Digital Economy. Applied Mathematics and Nonlinear Sciences, 9 (1), 1-16	Academic Journal Paper	Explores the impact of the ecosystem model of enterprise management innovation on the impact of enterprise management in the digital context. Empirically analyses the management effectiveness of China's construction industry. Enterprise performance*digital innovation ecosystem index* periodic cost*number of R&D personnel, and the digital innovation ecosystem is significantly related to enterprise performance. Designs a corporate management strategy for the digital innovation ecosystem in the context of the digital economy.
7	Liu, H., Ju, Q., Zhao, N., Li, H. and Skibniewski, M.J. (2022) Value Proposition for Enabling Construction Project Innovation by Applying Building Information Modeling, 2586307, 1-13	Academic Journal Paper	Explores the innovative potential of Business Information Modelling (BIM), specifically its value in enabling construction innovation (CI). Through reflective research and a literature review, the relationship between BIM and CI is redefined, Extra attention should be paid to BIM-enabled systematic collaborative innovation and digital innovation ecosystems with BIM as the core infrastructure that integrates the physical space with cyberspace to accelerate radical innovation.
8	Oke, A.E., Aliu, J., Mwanaumo, E.M.M., Abayomi, T. and Kahanji, C. (2023) Leveraging gamification to enhance productivity and employee engagement in the Nigerian construction industry. Built Environment Project and Asset Management, 13 (6), 813-829	Academic Journal Paper	Four key clusters of gamification areas of application in the Nigerian construction industry were identified – safety and quality, project management, innovation and efficiency and workforce development. By integrating game elements into these critical areas, construction organizations in Nigeria can enhance worker engagement, increase productivity and improve safety, ultimately leading to better project outcomes.
9	Zhang, R., Wang, Z., Tang, Y. and Zhang, Y. (2020) Collaborative Innovation for Sustainable Construction: The Case of an Industrial Construction Project Network. IEEE Access, 8, 41403-41417.	Academic Journal Paper	Explores complicated relations of stakeholders in inter-organization collaborative innovation, which is an important process to realize innovation in sustainable construction. Sheds light on the internal mechanism of innovation from the network perspective to promote the performance of innovation, via an industrial construction project in China. Adopts Social Network Analysis (SNA) method and in-depth quantitative data analysis of interviews. Key actors in the network, gatekeeper, coordinator and champion, are revealed.
10	Zhang, R., Xue, X. and Zhang, Y. (2021) The cascade effect of collaborative innovation in infrastructure project networks. Journal of Civil Engineering and Management, 27 (3), 175-187.	Academic Journal Paper	Uses network science theories to shed light on the cascade processes of cooperative behaviors in the evolution of collaborative innovations within infrastructure project networks and the impact of various network structures on the cascade effect. The number of initial innovations correlates with the role that the initial adopters play, and the cascade effect of collaborative innovations is contingent on project network structures. Network connection is positively correlated with cascade speed, scale, and time to reach a stable state.

Output	Output Reference	Type of Output	Relevant Findings
11	Bolton, S., Wedawatta, G., Wanigarathna, N., & Malalgoda, C. (2022) Late payment to subcontractors in the construction industry. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 14(4), 04522018.	Academic Journal Paper	Quantifies the extent of late payment and late release of retention and their effects on construction subcontractors in the UK. Analyses payment data of 30 selected projects (355 payments) from a case study and a supplementary questionnaire survey with 21 subcontractors. Late payment was observed in most of the projects (77%) and 46% of the payments, suggesting it is common practice. There was no statistically significant link between payment delay and contract sum, subcontractors are likely to experience longer payment delays in projects with a higher number of payments. The late release of the second half of the retention posed an even more significant problem to subcontractors, with a considerable portion of the income (upward of 2.5%); sometimes the entire profit, being held up for nearly 2 months from the due date. The findings highlight that despite regulatory and contractual measures to address the issue of late payment, it remains prevalent. PBAs, central retention deposit schemes, and smart contracts offer potential to mitigate payment delays.
12	Tezel, A., Febrero, P., Papadonikolaki, E., & Yitmen, I. (2021). Insights into blockchain implementation in construction: models for supply chain management. Journal of management in engineering, 37(4), 04021038.	Academic Journal Paper	The interest in the implementation of distributed ledger technologies (DLTs) is on the rise in the construction sector. One specific type of DLT that has recently attracted much attention is blockchain. Blockchain for construction has been mostly discussed conceptually to date. Presents empirical discussions on supply chain management (SCM) applications of blockchain for construction by collecting feedback for three blockchain-based models: PBAs, reverse auction-based tendering for bidding, and asset tokenization for project financing. The feedback was collected from three focus groups and a workshop. The working prototypes for the models were developed on Ethereum. The implementation of blockchain in payment arrangements was found to be simpler than in tendering and project tokenization workflows. A broad set of general and model-specific benefits/opportunities and requirements/challenges was identified. Some of these include streamlined, transparent transactions and rational trust building, and the need for challenging the sector culture, upscaling the legacy information technology (IT) systems, and compliance with the regulatory structures
13	Yazicioglu, E., & Kanoglu, A. (2022) A project procurement model enabling competition by design concept by integrating performance-based assessment (PBA), process-based estimating (PBE), and cost network modeling (CNM) tools. International Journal of Construction Supply Chain Management, 12(2), 65-92.	Academic Journal Paper	Existing cost and time estimation approaches significantly impact clients and construction firms when cost and timing projections deviate significantly. Developing concepts such as "competition by design" enforce the performance-based assessment (PBA) method that pushes designers of the building and its subsystems to select new solutions that promote national research and development (R&D) activities in developing countries. Yet, this strategy necessitates more sophisticated, integrated, and innovative solutions in the project procurement processes, as contractors submit their designs rather than the client providing a single, unique design. Presents a procurement model that enables the "competition by design" idea to serve the needs of all stakeholders in the construction industry by merging conceptual and practical components and tools. Throughout the construction of the proposed model, a "systems approach" was utilized. First, the problem and its constituents were investigated using the top-down method, and then the model was synthesized using the bottom-up method

Output	Output Reference	Type of Output	Relevant Findings
14	Sheamar, S., Wedawatta, G., Tennakoon, M., Palliyaguru, R., & Antwi-Afari, M. (2024) The potential of new models of construction procurement to counter cost overruns in construction projects: An exploratory study from a contractors' perspective. Journal of Financial Management of Property and Construction, 29(2), 211-228.	Academic Journal Paper	Reviews the features of the new models of construction procurement (NMCP) and assesses their potential to reduce cost overruns in construction Primary data were obtained through exploratory, semi-structured interviews using a case study approach. Found clients' lack of knowledge was a key issue in procurement that interlinks with many factors causing cost escalation. Suggests that the features contained within the NMCP, such as early contractor involvement and collaboration throughout the project team, have the potential to make a positive contribution to addressing cost escalation Recommends awareness of the NMCP be raised throughout the industry, and simplified information made available to help widen uptake of these contemporary procurement methods. Demonstrates how novel and innovative collaborative strategies such as open book costing, PBAs and shared pain and gain mechanisms can be implemented as part of the procurement strategy and contribute towards minimising the cost escalation inherent in construction projects.
15	Ahmadisheykhsarmast, S., & Sonmez, R. (2020) A smart contract system for security of payment of construction contracts. Automation in construction, 120, 103401.	Academic Journal Paper	A novel smart contract payment security system named SMTSEC is presented for eliminating or reducing payment issues in the construction sector. The SMTSEC ensures security of payment of construction contracts through an automated computerized protocol that runs on a decentralized blockchain. The potential of the proposed SMTSEC is studied through a real construction project. The main contribution of the SMTSEC is that it provides a new method for timely and transparent payment of construction projects by guaranteeing security of payment for works under construction without requiring administrative costs and burdens of trusted intermediaries such as lawyers or banks.
16	Scott, D. J. (2025) A proof of concept of a project bank account (PBA) blockchain payment application for the construction industry (Doctoral dissertation, UCL (University College London)).	Doctoral Thesis	Explores the cash flow problem from the technology perspective, particularly whether the programmability of smart contracts (SCs) and the general-purpose protocol layer of the blockchain (BC) can be used to increase systems integration cash flow automation. Proposes a PBA BC application and tests its hypothesis through proof of concept. Data is collected from two groups of study participants: (1) construction practitioners with working experience of PBAs and (2) blockchain engineers with technical expertise in BC to validate the proposal from the organisational and technical perspective. Findings suggest: (1) BC and SCs can reduce the management workload of processing PBAs in the current climate; (2) BC and SCs include the potential to democratise PBAs across a broader percentage of supply chain tiers, (3) a BC-based PBA can be set-up within a day (as opposed to weeks using normal banking procedures), and finally, (4) BC provides a trusted data layer for improving the granularity and traceability of cash flow in payment performance reports.
17	Scott, D. J., Broyd, T., & Ma, L. (2022) Conceptual model utilizing blockchain to automate project bank account (PBA) payments in the construction industry. In Blockchain for Construction (pp. 141-165). Springer Nature: Singapore.	Book Chapter	Provides a high-level conceptual model utilising blockchain to automate project bank account (PBA) payments. The proposed conceptual model allows project participants to approve and execute automated payments through user dashboards. To mitigate issues/costs relating to smart (Ethereum) contracts, transactions in the PBA blockchain model are instantiated through an off-chain application, which stores pre-executed transactions in the form of signed messages. These messages are pushed to the blockchain and converted to transactions once they are approved by validating authorities. The result is a strategy to achieve payment automation at a more economical cost. The proposed model illustrates a high-level amalgamation of PBA, blockchain, off-chain, and asset tokenization.

Output	Output Reference	Type of Output	Relevant Findings
18	Scott, D., Broyd, T., & Ma, L. (2022) Conceptual framework of a Project Bank Account (PBA) blockchain payment application for the construction industry. European Conference on Computing in Construction, European Council on Computing in Construction (EC3), Ixia, Rhodes, Greece July 24-26, 2022, Vol. 3, pp.0-0)	Conference Paper	Investigates whether blockchain can be used as an alternative system for executing PBA payments.
19	Scott, D., & Broyd, T. (2024) Investigating hosting project bank accounts (PBAs) on the blockchain and its potential value contribution to the UK construction industry. Journal of Information Technology in Construction (ITcon), 29(41), 935-975.	Academic Journal Paper	Proposes a PBA blockchain application and tests its hypothesis through proof of concept. Data is collected from construction consultants with working experience of PBAs to validate the proposal from the enterprise perspective. The findings suggest four key practical implications: (1) The proposed application reduces the PBA management workload of contractors due to process flow automation, (2) blockchain and smart contracts include the potential to democratise PBAs across a broader percentage of the supply chain, (3) a blockchain-based PBA can be set-up within a day (vs weeks with banks) and stores transactions permanently (vs a one year cap with banks), and finally, (4) blockchain can improve the granularity and traceability of cash flow data in payment performance reports.
20	Scott, D., Ma, L., & Broyd, T. (2024) Project bank account (PBA) decentralised application for the construction industry. Construction Innovation: Information, Process, Management. https://doi.org/10.1108/CI-04-2023-0067	Academic Journal Paper	Meets adoption challenges to PBAs, such as systems fragmentation and a lack of incentives for main contractors to adopt them effectively by investigating how to reduce systems fragmentation in construction by integrating PBA procedures with existing management workflows to increase payment automation, resulting in improved cash liquidity and better incentives for using PBAs. A PBA blockchain decentralised application is developed, presented and critically evaluated. Blockchain is used because of its permissionless, license-free, open-source and immutability properties. It is a suitable general-purpose technology layer for building and testing applications without the limitations associated with centralised technologies, such as high proprietary fees, vendor lock and intellectual property restrictions. Demonstrates how a blockchain application can integrate siloed construction workflows such as cash flow scheduling, supply chain management and payment executions, reducing the management workload for implementing PBAs. The proposed application is open-source and replicable, and its user interface is available for external testing.

Output	Output Reference	Type of Output	Relevant Findings
21	Ing, W. (2023) Has the government WASHED its HANDS? Construction News, 40-43. Retrieved from https://www.proquest.com/trade-journals/has-government-washed-hands/docview/3069281656/se-2	Trade Journal Opinion Piece	Examines the UK government's efforts to help address the construction industry's issues with late payment and retentions. Despite policy interventions in 2010, 2014, and 2017, late payment and retentions remain widespread. Government departments are not following official guidance aimed at speeding up payments. PBA) have been successful in Scotland and Wales but are not being used consistently by government departments in England. The voluntary Construction Supply Chain Payment Charter and Prompt Payment Code have had limited effectiveness. The government introduced the Duty to Report on Payment Practices and Performance, but the data has flaws and there are no sanctions for late payment. The government has not legislated to eliminate retentions but wants to see them gone. Main contractors also want to eliminate retentions, but progress has been slow. The Construction Leadership Council is working on alternatives to retentions and lobbying for their removal from contracts.
22	Marrs, C. (2023) No regulatory help in sight as suppliers shoulder the cost of firms' failures. Construction News, 3. Retrieved from https://www.proquest.com/trade-journals/no-regulatory-help-sight-as-suppliers-shoulder/docview/3068163376/se-2	Trade Journal Editorial	Many commentators argue for the implementation of PBAs to protect subcontractors. However, a proposed amendment to the Infrastructure Bill, which aimed to make PBAs compulsory for contracts over £2 million, was opposed by the UK government. While the government acknowledged the effectiveness of PBAs, it deemed mandatory implementation as burdensome for main contractors. The government's position has been criticized for its inconsistency, especially considering the increasing number of administrations in the construction sector and the uncertain economic outlook. The issue of PBAs is likely to face further scrutiny in the future.