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Are Blockchain-based Systems the Future of Project Management? A Preliminary Exploration

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Abstract
Blockchain technologies have introduced a platform for a new wave of project management systems, providing managers with a range of characteristics, capabilities, and feature sets to aid their practice as they engage in increasingly complex processes and projects. This paper presents an explorative case-study in which open-ended interviews were conducted with practicing project managers. The interviews are analysed to understand currently deployed project management tools, technologies, and methods and to contextualise how blockchain-based systems may allow for improvements. Five constructs emerge: transparency, control, dynamic status updating, incentives, and trust. Feedback suggests blockchain-based alternatives could offer significantly better performance within each of these constructs, and thus should be explored as the technological backbone to the next generation of project management systems.

Keywords: *Blockchain; Distributed Ledger Technology; Project Management; Decentralised Applications; Project Management Software*

1. Introduction

The most notable instantiation of distributed ledger technology (DLT), otherwise known as blockchain technology, emerged in 2009 with the cryptocurrency Bitcoin [1]. The technology has since become a leader in innovation [2], widely recognised as defining an era using the combination of consensus mechanisms, applied cryptography, and database technology [3]. A decade since its origin, its impact is beginning to be felt across a wide range of fields: digital currency, supply chain management, digital identity, distributed computing, commodity and security tokenisation, and decentralised finance (DeFi) platforms, to name a few. Since the emergence of Bitcoin, one of the most impactful developments has been blockchain-based distributed application (Dapp) smart contract platforms, which allow the deployment of programmatically based business logic in a truthful, open, and transparent fashion [4, 5].

This paper frames concepts in the domain of project management, by understanding how it relates to key characteristics of blockchain technology. The study comprises a series of open-ended interviews with those currently engaged in the practice of project management. A mixed method of qualitative open, axial, and selective coding [6] uncovers constructs which correlate strongly with explicit characteristics of blockchain technology systems. These constructs are viewed as the rational base from which a relationship between project management and blockchain technology may evolve. The main contribution of this paper is the recognition that blockchain seems well suited to the demands of project management, positioning a proposed blockchain-based project management system as a viable solution for a series of stress points currently found within the practice.

2. Project management

Businesses are becoming more 'projectified' in the 21st century, as flexible and agile organisational structures are increasingly necessary for dynamic, technologically led markets [7]. Firms are understanding the significance of 'effective' project management, adopting rigorously structured methodologies into their operational practice in pursuit of operational efficiency and/or competitive advantage [8]. Project management combines several related domains: organisational studies, management science, psychology, governance methodology, politics, risk management, behavioural studies, information technology, and so on. Artto and Kujala [8] take a macro lens, detailing their business organisation framework (see Figure. 1) that places firms into one of four constructs, depending on the level of engagement with the project management process:

The framework provides a method of understanding how firms navigate the field. The matrix details a spectrum ranging from 'one firm > one project' organisations, to 'many firm > many

project' networks. Firms are seen to be frequently adopting project-based methodologies into their daily operations.

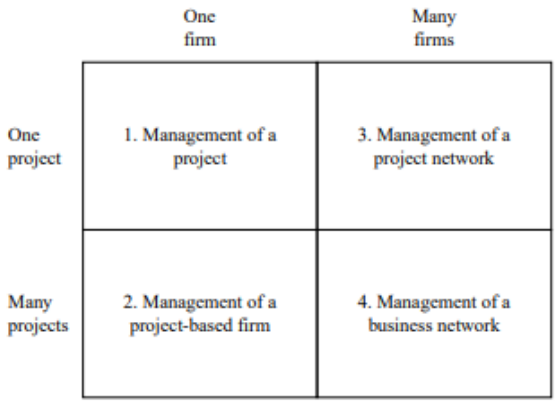

Figure 1. Framework for project business: Four distinct management areas

Unfortunately, the relationship between project management and the tools and technologies used within the practice is a somewhat neglected area of study. Many papers have discussed affordances and/or characteristics of specific technologies in relation to project management processes [9, 10], but often in a deterministic manner – highlighting how things 'are' with respect to a predetermined set of tasks, functionalities, or characteristics.

3. Project management tools

Software, tools, technologies, and information management systems have quickly become an integral part of the project management process, either as a method for better organisation, more effective governance, to reduce risk, manage complexity, to ensure procedural compliance, and/or to increase rates of both project and project management 'success' [11, 12, 13].

Questions concerning 'success' have predominantly focussed on how to increase the rates of 'project success' or 'project management success'. Project success is a measure against the stated objectives of the project, while project management success is a measure against more traditional metrics such as resource allocation, cost, time, and quality [14]. A comprehensive study of 70 large, multi-national organisations found 12 factors crucial to project success: various elements of risk management and project length were crucial to 'on-time performance', while 'on-cost performance' was predominantly associated with the management of project scope [15].

A more recent study has highlighted various 'models' of project management success. Radujkovic et al. [16] provide an overarching framework, directing a lens towards project management tools and techniques and highlighting their importance through case-study-based analysis focussed on certain aspects of project management, seeking evidence of behaviours, functions, and characteristics. The authors conclude that it is imperative that organisations familiarise themselves with a wide range of tools and software programs, urging education and adoption in order for better 'planning, monitoring and control optimisation' [16]. The authors also urge continual learning and investment to aid the continual development and evolution of tools, technologies, software, and methodologies. Jugdev et al. [17] detail a comprehensive statistical-based study, building on prior work by Fortune et al. [18], mapping the interrelation between broad project management tools and software, and specific project management methodologies such as risk management and scheduling. The highest degree of correlation is found between project management tools and risk management methodologies, implying that benefits are found in those specifically focussed towards the management of risk [17].

Caniëls and Bakens [11] conducted surveys with 101 project managers to understand the impact tools had on 'multi-project environments'. They found that that Project Management Information Systems (PIMS) positively contribute to the ability of project managers to make effective decisions based on better organisational skills and accessibility of information – informing decisions and aiding workflows. An alternative study attempted to empirically assess the overall 'quality' of PIMS, completed through a survey-based methodology with 39 project managers. The study concluded that PIMS had a direct impact on project managers' success due to better organisation of information, project planning, scheduling, monitoring, and control [12].

Cicibas et al. [10] show a detailed comparison of 10 project management software tools, while a more recent study details project management technology specifically designed for software development projects [9]. The need for a comprehensive project management tools study is grave, especially considering the increasing complexity that project managers encounter in the modern age [19]. This requirement is detailed more specifically for small- and medium-sized enterprises (SME), viewed as resistant to adoption of specific project management software [13].

4. Blockchain-based smart contracts

Distributed application platforms have been designed, for the most part, to act as a distributed computing network onto which programmable code, otherwise known as smart contracts, may be deployed [20, 4]. While the first smart contract platform, Ethereum, did not appear until some five years after Bitcoin – the concept originated in the late 20th century [5]. The idea was focussed onto aspects of political governance, decentralised organisation, and distributed consensus models deployed through mathematical rulesets – ultimately in the pursuit of trustless systems divorced from the failings of the politicised agent [21]. Smart contracts may be described as self-enclosed deterministic logic, written as computer code, designed for execution on a predefined distributed application platform. The platforms are predominantly forms of distributed ledgers, in which there exists

no single custodian of data or sole controller of the consensus ruleset. The main affordance of any contract executed on a distributed ledger platform is that it operates independent of any trusted entity. The contracts execute in trustless environments without the need for intermediaries to ensure the code is deployed correctly on behalf of the transacting parties [22]. This trust model ensures both parties are relatively certain that a contract will be executed, as agreed, once it has been initiated and logical conditions are met. Both parties may also be sure that an indelible record of all execution steps will be stored on a ledger that no one party controls and no one party can alter. This has meaningful ramifications for contract audibility, transparency, security, veracity, and efficacy [4].

5. Existing blockchain-based project management technologies

A potential realisation of a blockchain-based project planning and management solution emerged in mid-2018, with a project titled Zoom, which is marketed as a solution for developing and maintaining 'virtual organisations' comprised of geographically disparate members. The creators state their solution is a distinct method for organising remote workers around shared project goals, with blockchain technology being integral to contractual agreement, management, execution, as well as providing a platform for transparency of work flows and payments [23].

A second solution, Alehub, positions itself as a provider of a project management framework, designed to support contract execution, contract settlement, and organisation procedures and processes amongst parties coordinating in cooperative projects. The main focus of the company seems to be moving contract definition, execution, and settlement onto a custom-built smart contract-distributed ledger platform, using a custom value exchange token (ALE Token) to coordinate exchanges between transacting parties [24]. Alehub believes that doing so will ease a number of frictions currently found in the project management space: contract negotiation, settlement, and arbitration, as well as easing processes for short-term contract workers employed through digitally interfaced peer-to-peer labour markets like UpWork [25] or TaskRabbit [26].

Colony proposes a method of function (interacted through smart contracts) for organising and managing decentralised workforces [27]. The creators envision the protocol layer as providing various functionalities, such as the creation of tokens, managing reward mechanisms, and as a tool for reputation management. He attempts to apply this functionality to aspects of human organisation, affecting rules between people to help them organise better by aligning incentives around shared goals.

In a similar manner, Autark focusses on providing tools that 'empower agency and large-scale coordination' [28]. Their product suite includes an application that attempts to incorporate specific project management functionality onto existing GitHub [29]-based open-source project code repositories. Their portfolio of applications also includes a rewards mechanism module and a voting mechanism module. The functionalities address specific issues that arise within the project management process, and especially those that arise in decentralised organisations or inside projects that comprise of a number of remote members.

6. Existing studies based on the relationship between blockchain technology and project management

The application of blockchain technology to the project management sphere is in a nascent state, with most implementations emerging within the last five years – at the most. However, initial research has been conducted based on the applicability of blockchain technology to the industry, on the premise that specific characteristics of blockchain technology and/or smart contract functionality are applicable to the complex, multi-agent, and sometimes stratified management of projects in the industry. Turk and Klinc [30] propose that blockchain-based systems provide solutions to aspects of construction information management, as well as specific general-purpose information management infrastructure that other solutions, systems, tools, and technologies may be built onto.

Mason and Escott [31] also did research on the efficacy of blockchain technology in the construction industry, specifically in relation to the proposed use of smart contracts in the creation, management, and execution of construction contracts. A survey was conducted, with 117 responses from those working within the industry. The findings reveal a general adoption hesitancy, framed by a movement away from important human interaction. Automatically executed code, code immutability, and dispute resolution were all seen as factors to consider, while a reduction in the levels of human interaction was seen to be an 'unknown' quantifier, especially in an industry that relies on humanistic elements to ensure smooth contract execution, and/or the resolution of issues and disputes mid-contract. The authors note that human interactions are key to the construction industry, providing mechanisms for building relationships, detailing the generalised fear that technology may be detrimental to the benefits that accrue from forging humanistically based business relationships.

To address the paucity of research studies explicitly concerned with the relationship between blockchain technology and project management, this paper presents an explorative case-study focussed on exploring the symmetry (if one exists) between the field of project management and blockchain technology.

7. Methodology

This paper presents a qualitative analysis of a series of semi-structured interviews conducted with project managers currently engaged in the project management field. The managers have experience in a diverse range of industries: finance, software development, construction, research institutions, pharmaceuticals, etc. (see Table 1). Participants are drawn from a demographic range representative of the field, diversity in age, gender, geographic, and jurisdictional location. All participants have at least three years of practical project management experience, and all have certified project management qualifications through bodies such as the Project Management Institute (PMI), or an equivalent one. One participant requested to remain anonymous, and this request has been respected.

Table 1. Project manager profiles

Project manager interview profiles				
Participant	**Industry**	**Years experience**	**Location**	**Current workplace**
Participant 1.	Software development	>3	Ireland	Dell
Participant 2.	Multiple	>15	United States	SmartProjex
Participant 3.	Software development	>10	Holland	SAP Holland
Participant 4.	Pharmaceuticals	>5	Ireland	Johnson & Johnson
Participant 5.	Anonymous	>5	Anonymous	Anonymous

Interviews were conducted over a period of two months, beginning in February 2019 and completed in March 2019. The research may be seen as explorative, completed through a case-study approach [32]. The case-study approach is viewed as the most suitable, as the study explores a loosely bounded environment [33, 34, 35]. The number of participants is seen as providing an initial sample set from which general themes and constructs should emerge.

The focus of the study is narrowed to a series of questions surrounding practices, behaviours, and opinions of project managers with respect to existing software management tools and technologies. This elucidates areas where potential benefits of a tool built on, or deploying elements of, blockchain technology and/or smart contract functionality may exist. The data gathering and analysis process borrowed methodologies from grounded theory (GT). GT was developed in the 1960s by two sociologists as they proposed a system for 'theoretically grounded' qualitative analysis [36]. The study presented in this paper borrows from later refinements, especially the more pragmatic open, selective, and axial coding techniques used within the analysis methodology proposed by Corbin and Strauss [6]. This allows the theory to develop in a flexible manner, while still being informed by a hypothesis formed at the origin of the study [37].

8. Findings

The open-ended nature of the interview process ensured participants were free to talk about topics of importance, without conversations being unnaturally steered towards biased frames of reference. The interviews contained a number of key questions addressing general themes, but allowed scope for change and probing of any interesting avenues. Participants were encouraged to frame questions with their personal experience and context, while being aware that the interviews sought to understand how project management tools and technologies are used in practice; framing key constructs around the development of a new system or tool, and the functions and characteristics it would offer. They were not informed that the tool would be based on blockchain technology until the final section of the interview.

Below is a summary of participant responses, organised through the frames that emerged (see Table 2). There is a loose consensus on almost all of the constructs. Transparency is the only one in which there was some divergence of opinion, due to the nuanced nature of the construct. There is also some divergence on the nature of the proposed incentive systems with apprehension communicated with respect to how such a system may actually be deployed. There were also concerns raised with how performance might be measured. The following sections will detail some of the most pertinent sections of the interviews.

Table 2. Analysis of participant views

Analysis of participant views					
Proposition	**Participant 1**	**Participant 2**	**Participant 3**	**Participant 4**	**Participant 5**
Transparency	+	-	+	+	+
Control	+	*	*	+	+
Dynamic status updating	+	-	+	*	+
Incentive system	+	*	*	+	*
Trust	+	*	+	+	+
Key: Positive (+); Negative (-); Neutral (*)					

9. Transparency

Blockchain-based systems afford a substantial degree of information transparency. Understanding whether project management would benefit from a move towards more

openness and transparency in processes, procedures, and reporting is a key question. The question was posed on whether incorporating a significant level of transparency would be beneficial. Participant responses were, for the most part, congruent. Some divergence surrounding reporting bias and reporting method did emerge.

All participants agreed that one of the main frictions found within their project management experience was lack of transparency – the appearance of information asymmetry, 'locked' data silos, and the ability for certain team members and/or stakeholders to maintain control on the levels of information sharing. A view was raised regarding the impact a transparent and open system would have on information accuracy – the ability for senior management to appraise impact of 'scope change'. Reporting could, in theory, accurately convey how decisions impacted the project, or how they might impact the project in the future.

Lack of transparency was found to be mitigated, presently, by more transparent project management tools, such as Trello [38]. A participant discussed how previously information asymmetry was a problem, as no central repository existed to ensure all project members were working from the 'same page'. Another participant, Participant 2, raised a concern regarding 'blame culture', noting how corporate ideologies may not be wholly congruent with open and transparent project management systems:

> Unless you are working in a culture that has encouraged people to come forward with problems, and has taken an approach that is very team oriented and not a culture that blames people with problems, I think what you are going to find is that people don't want management to know where things really stand. (Participant 2)

This blame culture perspective can be compared with the response regarding transparency, and whether or not everything needs to be known by all members of a project. It was predominantly detailed that varying degrees of opacity (taking into account access rights, information security, and information privacy) would be beneficial, especially if transparency or openness was a core trait of a system (at the technical level) and the management (at an ideological level).

10. Control

There was loose agreement amongst participants that centralised control of data repositories was not desirable, leading to issues regarding data security, audibility of actions, and information asymmetry – distinct concerns when projects started to break down, or when dealing with sensitive or valuable information. The ability to maintain a record of changes, additions, deletions, along with a day-to-day tracking of issue evolution was seen as beneficial, guarding against lack of audibility when undesirable actions occurred.

Participant 1 noted how having a mutable information store allowed for perception to be skewed if information was deleted or hidden by somebody with the required authority or access control. This potential for information asymmetry was seen as a pitfall of data stores or repositories with centralised control. The concept of data 'snapshotting' was mentioned as a method for mitigating against this type of malicious action through the 'back-up' and restore processes. An instance of 'deletion' was discussed, highlighting the determined need for retrospective audibility of actions:

> I have seen it [issue deletion] to be pretty honest. I have seen user stories just disappear. … Ideally when a scrum team identify a defect, they would log it in Jira [a project management software], but imagine if the amount of defects just keeps increasing. So then there are serious questions about the type of quality standards you are following...and I have seen defects just [disappear] … they are gone. (Participant 1)

Control of information became a contentious issue for another participant (Participant 5), as they noted a project in which manual, hand-written information, or 'handover sheets', failed to record an objective version of events. Duplicate sheets would start appearing as it was beneficial for contractors to show a subjective version of events, as opposed to one 'handover sheet' recording the actual, objective, and order:

> Whoever has the handover sheet is allowed to work in the room, and you have to keep to a certain schedule, but that obviously never happened. … These duplicate sheets would start showing up, the room being handed over to somebody, when it wasn't handed over … that created an absolute nightmare. (Participant 5)

In one particular organisation, audibility is leveraged through consistent 'timesheeting', a process where actions and deliverables are reported manually on a weekly basis. However, it was unclear whether data repositories were backed up along with the reporting procedure. It was also communicated that the burden of meeting timesheeting targets placed abnormal stresses on projects, especially if they were complex or under resourced.

The discussion regarding audibility may also be framed as a conversation regarding information control. Centralised control of information and data repositories may be seen as a limiting factor, as concepts of ownership lead to tensions across departments or teams; information used as negotiation and bargaining tools with issues arising around retrospective auditing and/or measurement of process, performance, efficiency, and effectiveness. Information control was also viewed as a security issue, with Participant 5 noting that cloud-based servers were a distinct security concern for the company he worked in, especially regarding sensitive documents that would otherwise fall under the security model of non-

disclosure agreements. The relationship between information control and information security is worth noting, as there seems to be a balancing act at play. Firms must consider whether they wish to allow open access of information to project members at times they require, or maintain strict access control that they can monitor and audit as and when required.

11. Dynamic status updating

There was loose convergence that dynamic and real-time updating of information is beneficial within project management. 'Dashboards' were mentioned by a number of participants – an effective way of communicating information to various stakeholders and/or project members. However, there was also an agreement that 'dashboard technology' coupled with collating and sharing of information procedures and processes are currently far from perfect. From the perspective of a project manager, the ability to create an easily understandable overview of the whole project is viewed as beneficial. However, there was some concern with giving everybody the same overview, or allowing all stakeholders unfettered access to all information pertaining to the status of a project. Information differentials were also a problem, as information elements may pertain to varied times – one information element may be up to date (e.g. timesheets) while another may lag behind by one or more time periods (e.g. financials), ensuring that the dashboards presented were not accurate or, even worse, skewed.

One participant worked in a firm described as 'project-orientated'. The firm used 'timesheets' so that stakeholders could obtain an overview of labour and resource costs at a regular and consistent time interval. This method is seen as beneficial, as it gave a consistent overview of the cost status of the project over a given time period. Of course, there is a week-long lag, given the time frames between each 'update'. In dynamic industries, or time limited projects, a week might be seen as an inordinate amount of time, potentially problematic if a stakeholder needs to make a crucial decision based on the most up-to-date information possible.

12. Incentive system

The question of whether or not it would be beneficial having an incentive system built as a feature of a project management tool was posed to the participants. There was a degree of perspective divergence around this issue. In theory, a value exchange token could be used as the monetary exchange mechanism to incentivise both individual performances (i.e. a token distributed when one individual completes work in an efficient or efficable manner), and also as a tool for contract compensation (i.e. when work is completed, tokens are exchanged). A smart contract platform offers the potential to deploy both mechanisms, as they may be programmed at contract initiation to serve whatever purpose is necessary for the specific work package. In this manner, parties can be confident that contract execution remains deterministic, even given external pressures.

One participant communicated how a previous firm, with which he worked, employed an incentive system – a psychological reward mechanism for completion of tasks. In the firm, a bell was used – rung after a certain stage of the project was completed successfully. The bell became a positive reinforcement tool that members began to work towards – a recognition that the project was moving forward or towards its desired end goal:

> We used to implement this … following scrum [a method within 'agile' project management]. A scrum, it's basically a two week sprint … we had this very simple thing, it was a bell. So any time someone would complete a user story assigned to them they were given that bell to actually ring. This really encouraged people to get things done on time. There was some gratification involved. The incentive became that you get to ring the bell. [It created a mood] Everything was flowing. (Participant 1)

There was also mention of a direct incentive system where project managers were given 'points', which they could distribute – rewarding project members as they see fit. These points could then later be traded in for real-value items on a specific website:

> Project managers were given 75 points per quarter, per resource. We used to call it celebrating performance points … anything interesting that happened, so for example if someone did something beyond their call of duty … we could award that … it was not transparent. There might be cases where the project manager might give it to his favourite. So to overcome that, there was an audit system. It would do these random samples – who has been given the points, how much … but this really helped a lot. It was an immediate gratification system. (Participant 1)

Participant 2 made a distinction between compensation and incentivisation, detailing how a token-based system could aid in the deployment of transparent and open compensation contracts based on deliverables, that is, pay to project members once a stage is satisfactorily completed. These deliverables would be set out during contract initiation, and agreed by all parties. This distinction is crucial, as tokens may be used for both purposes. Other participants could see the theoretical value of a native incentive system, but concerns were raised regarding transparency and audibility, questioning whether such a system would remain objective once distribution is centralised, in the control of a manager who may be influenced by explicit or implicit biases.

13. Trust

A concept that repeatedly arose in all interviews was trust. Participants converged around the perspective that leveraged trust helped build better relationships between project members and stakeholders. Trust is seen as a bind that affects varying aspects of both 'project success' and 'project management success'. Participants viewed technology as potentially affording an increase in levels of trust, aiding aspects such as transparency, traceability, audibility, verifiability, robustness, and openness, while also providing the technological platform on which a community may be built – either through communication, incentive systems, or common processes and procedures amongst all members of the project team, and management.

Participant 1 mentioned trust with respect to the centralised ownership of data, detailing how changes of project scope may be mitigated against if an immutable record of initial scope was documented at project initiation, as well as any agreed changes being noted within some form of read-only, access-controlled format:

> I think that [immutable storage] would really help us … in terms of trust to be honest. … Initially you have this set of requirements … apparently it is frozen in a sense that everyone signs off and agrees … but it is not really frozen. … If you have a system that says, ok, these are the set of requirements and now it is frozen and no one can make the changes to scope unilaterally, that's pretty interesting, yeah. (Participant 1)

Participant 3 discussed ownership of data, noting how relationships may not always be trusting. A system that was conducive to more trustful engagements, especially the surrounding information, was seen as beneficial. The interviewee highlighted that mutable results such as timesheeting or documenting could become points of friction in relationships. Trusted documentation is important, so that issues in relationships can be traced to their origin, or highlighted to all parties in a common 'language' when necessary.

The link between increased transparency, openness, and trust is echoed by another participant, as they described the relationship between project management and output quality. Managing expectations and scope was discussed with a system that allowed for clear and transparent communication of some form of 'immutable project charter' which was viewed as beneficial. Anything that could help manage shifting expectations in a clear and transparent fashion is something that could aid project smoothness and help mitigate against tensions that arise in the project as it develops.

14. Discussion

The study presented attempts to ascertain if a symmetry exists between project management practices and certain characteristics of blockchain technology. A series of interviews are conducted from which five constructs emerge: transparency, control, dynamic status updating, incentives, and trust. The constructs are seen as higher-level frames through which a thorough analysis of the relationship between blockchain technology and project management software may be detailed in future studies. It is viewed that each construct is an area in which a system built on blockchain technology might improve the status quo, especially from the context of a purpose-built project management tool whose underpinnings seek to leverage specific characteristics of the technology. The article details convergence of perspective from five practicing project managers; characteristics of blockchain technology would be beneficial to their work, especially if these characteristics were built as features of a specific project management system. If certain characteristics of existing tools can be combined with some of the robust, secure, decentralised, smart contract execution aspects of blockchain-based systems, there is reason to believe that significant improvements might be made.

The core limitation of this study is that only five project managers were canvassed for opinions. This limited the sample size and affected the veracity of the coded constructs. While this is acknowledged as being a considerable weakness, it is felt that for an explorative investigation, the insights and overarching frames remain valid – especially in the context of directing further research. Future studies might explore how existing blockchain-based systems might explicitly affect, enhance, or leverage existing project management methodologies and/or processes. This would allow evidence-based feedback to be iteratively provided to developers of such systems, informed by real-world use, providing a template for the future development of blockchain-based project management systems.

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None declared.

Ethical approval:
Not applicable.

Author's contribution:
Robin Renwick, is main author and was responsible for writing the manuscript, collecting data, and proof reading.

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