

Integrating Blockchain Innovation: A Sustainable Adoption Model for Business

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Abstract

Blockchain technology holds significant promise for driving innovations across diverse industries, businesses, and applications. Recognized as a crucial source of competitive advantage in a fast-evolving environment, blockchain is anticipated to contribute substantially to sustainable economic and social development. Despite these high expectations, many blockchain projects currently face high failure rates, leading to negative impacts on various aspects of economic and social sustainability, including corporate governance, risk management, financial management, human resources, culture management, and competitiveness. This paper evaluates adoption models, identifying both risk and success factors. It introduces an integrated adoption model designed to operationalize, measure, and manage blockchain-driven business innovation sustainably. An empirical study involving 20 industry sectors and 125 business leaders was conducted to assess the model's applicability. The findings indicate that the adoption model has the potential to support the sustainable implementation of blockchain technology for business innovations across various industries and applications. Future research and industry activities should continue validating this model through further case studies.

Keywords

Blockchain, Sustainable Adoption Model, Economic and Social Sustainability, Financial Management, Blockchain-Driven Business

1. Introduction

The potential for blockchain technology to transform consumer experiences, operating systems, goods, and business models is immense. Both the act of inventing and the product it produces are essential to maintaining a competitive edge in the modern business world. But, just like with previous fundamental technologies, blockchain innovation in business will require systemic adjustments to encourage broad adoption [1]-[3]. In spite of the fact that blockchain technology has a lot of potential uses, many initiatives in different industries fail or aren't mature enough. The failure to implement standards and strong requirements engineering practices is to blame for this, as these are crucial for blockchain projects to succeed and remain operational [4].

Although blockchain technology has great potential, most blockchain ventures have failed to achieve long-term success in the past [5]. There were no solid models for managing the long-term adoption of blockchain-driven business innovations, which is why almost 92% of blockchain projects failed till 2019 [6]. Midway through 2021, there were 2047 blockchain and cryptocurrency projects that failed, highlighting the larger challenges of technology-driven transformation [7]-[11]. When it comes to corporate governance, risk management, financial management, human resources, cultural management, and competitiveness, these high failure rates can have a severe influence on economic and social sustainability. Despite the fact that 70 million blockchain wallets are presently in use, mostly for cryptocurrency transactions in the decentralised banking and gaming industries, blockchain technology is still in its early phases of being widely adopted by industries [5] [12]-[16]. According to estimates, 90% of business blockchain platforms will have to be upgraded in order to make them faster and more scalable, because first-generation blockchains have shown major shortcomings [17]. Business model innovation, value chain development, and enhanced data management security are the primary reasons industries are embracing blockchain technology.

According to Iansiti and Lakhani [18], there are two main aspects that impact the increasing need for eco-friendly management of blockchain-driven corporate innovation: complexity and novelty. The blockchain techniques are novel because they are unlike anything that has come before, creating a need to explain in detail the challenges they solve and how they are different. Meanwhile, complexity refers to the level of ecosystem coordination that is necessary, with many different stakeholders working together to make the technology valuable. Taken together, these issues suggest that blockchain technology's broad adoption will be a slow game. In their Harvard Business Review article, Iansiti and Lakhani estimate that widespread adoption of blockchain applications might not happen for another decade or more, and that it will take a while before they reach critical mass and general acceptability. To guarantee the long-term success and influence of blockchain developments, this prediction highlights the necessity of a comprehensive approach to administration of their integration and deployment.

The key to long-term, widespread blockchain adoption is effectively managing

the complexity and novelty of the technology. Joining the “Technology Acceptance Model” (TAM) with the “Capability Maturity Model” (CMM) creates a strong adoption framework that helps blockchain technology accelerate sustainably [19]-[23]. The two most important parts of adoption, acceptance and maturity, are taken care of in this integrated approach. A user’s beliefs, attitudes, and intentions towards a system or technology have a role in the decision-making process known as acceptance [24] [25]. Important because it shows how open people are to using blockchain technology. Maturity, on the other hand, covers all the different ways in which people and organisations change in complicated contexts, and it shows how much new business features are integrated into different processes. An integrated adoption framework that combines the two models provides a more comprehensive view of blockchain adoption by capturing the dynamics of user behaviour and organisational development throughout the innovation process.

The innovation process necessary for blockchain adoption can be fully understood when acceptance and maturity are taken into account jointly. Perceived utility and ease of use are key factors in shaping user attitudes and intents, according to the Technology Acceptance Model (TAM), which centers on the user’s decision-making process [26]-[32]. Critical for the early adoption of blockchain technology, this model aids in identifying the elements that drive user acceptability. In contrast, the Capability Maturity Model (CMM) specifies the steps that businesses should take to become fully technologically integrated. From unplanned, early steps to planned, managed, and optimised procedures, there is a continuum here. The suggested adoption model combines TAM and CMM to guarantee that organisations may systematically grow and develop their usage of blockchain technology, in addition to addressing the initial acceptance of blockchain technology. With a focus on both maturity and acceptance, blockchain adoption may be approached in a sustainable and organised way, which will lead to its effective and widespread application across industries [25] [33]-[36].

Even while blockchain technology is booming, there isn’t yet a standardised structure for requirements management or a concentrated conversation about it in the business world. Because of this void, a thorough discussion is necessary to progress and make a contribution to this field. Business innovation stakeholders, according to one theory, are keen to embrace blockchain integration models that ensure the technology’s long-term viability. In order to manage blockchain-driven innovation efficiently, these stakeholders rely on standardised and operationalized risk and success variables, according to another theory. The ISO/IEC/IEEE 29,148 standard is a good illustration of this type of standard because it uses a life cycle-based approach to requirements engineering process and product definition [5]. By outlining a systematic framework, this standard can help direct the implementation and administration of blockchain technology, which is crucial for the long-term viability and efficient management of innovations. A stronger and more organised strategy for blockchain requirements management may be developed by

concentrating on these assumptions and current standards; this will allow for its wider and more efficient use in corporate innovation.

Existing research shows that blockchain technology has the potential to improve business efficiency, transparency, and security; however, recurring issues such as high project failure rates, limited adoption, and the lack of standardized frameworks and requirements engineering are critical for long-term use. Many studies do not take an integrated approach to user acceptance and organizational maturity; instead, they focus primarily on technological or adoption difficulties and fail to provide comprehensive answers. This study fills these gaps by presenting a complete framework that combines the Technology Acceptance Model (TAM) and the Capability Maturity Model (CMM), thereby easing both user acceptance and operational integration. This model seeks to establish a sustainable, systematic path for blockchain adoption in business, promoting both early acceptability and long-term profitability.

This study delves into the current literature on technology adoption management and proposes a new model, TAM + CMM, to handle requirements engineering and the elements that contribute to the success or failure of blockchain-driven business innovation in the long run. Here is the outline of the article: In Section 2, we lay out the methodology, tools, and questions that will guide our investigation. The findings are related to these inquiries that were posed in Section 3. In Section 4, we go over the findings and how they relate to sustainability, risk management, and blockchain technology. In Section 5, the study comes to a close and provides a look ahead to potential research endeavors.

An in-depth examination of blockchain adoption assumptions and maturity frameworks is required to understand its application in business. User attitudes and behavioral intents reflect how people perceive and interact with new technology, making acceptance an important consideration. Maturity, in turn, symbolizes the stages of development that enterprises go through while implementing blockchain technology. To guarantee that blockchain technology is strategically integrated and durable over time, effective adoption must strike a balance between acceptance and maturity. Standardized approaches for evaluating success and managing risks are critical to sustaining blockchain-driven business innovation. Establishing a methodology for measuring acceptance and maturity will help firms overcome hurdles and maximize benefits related to blockchain implementation.

The study focuses on a number of research topics to drive this exploration:

RQ1: How is adoption defined in the commercial and technology contexts?

RQ2: What existing ideas and patterns encourage blockchain adoption for corporate innovation?

RQ3: What gaps exist in our understanding of blockchain adoption and the technical requirements for long-term innovation?

RQ4: Which adoption techniques can align acceptance and maturity needs to support long-term blockchain-powered corporate innovation?

2. Materials and Methods

A quantitative secondary research technique was utilized in this investigation. A systematic literature review (SLR) was the first step in our evaluation of previous research. We used resources including Academia.edu, Web of Science, Elsevier's Science Direct, SSSR, ResearchGate, and Elsevier's Science Direct to find publications. Titles and abstracts were searched using keywords for this. Our research focused on sources published during the last five years, including industry publications and grey literature, due to the rapid evolution of the topic within the industry.

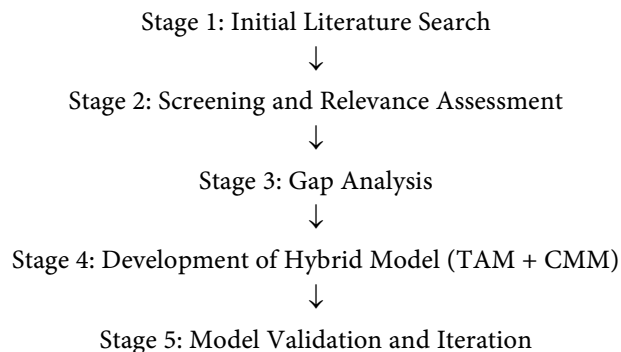
In our search, we utilized the following keywords: "acceptance models", "adoption models", "blockchain applications", "blockchain adoption", "blockchain innovation", "maturity models" and "sustainable blockchain". We aimed to find answers to our research questions by identifying applicable techniques to managing blockchain-driven corporate innovation. There has been a dearth of scholarly work focusing on blockchain adoption models, which is surprising given the industry's recent growth.

We also polled 125 CEOs from 20 different industries as part of our empirical study. Interviews with experts and surveys were used in this research. We made sure there were experts from all levels of responsibility and a wide range of industries represented. The overarching goal of this strategy was to shed light on the innovation and use of blockchain technology in corporate settings.

3. Results

An initial search on Elsevier's Science Direct database, using keywords like "blockchain applications and adoption" and "sustainable blockchain", yielded a broad range of results, which were narrowed to focus on adoption dynamics relevant to the research questions. Screening included validation based on viewing frequency, citations, and sharing metrics. Industry-specific applications in healthcare, logistics, and IoT were examined, revealing a lack of unified adoption models that incorporate both risks and success factors. To address this, the study developed a hybrid TAM + CMM adoption framework for sustainable blockchain integration. A figure summarizes the study's structured stages, from literature review to model creation, illustrating the framework development process clearly.

Study stage:



Following the method proposed in Section 2, we conducted our literature review primarily during the summer and fall of 2021, with a validation phase at the end of the same year. Our initial search on Elsevier's Science Direct database yielded 2559 results for the query "blockchain applications and adoption," showing an increase in publication volume from five articles in 2016 to 1185 articles in 2021. Out of these, 387 were reviewed publications. A subsequent examination of these 387 results revealed that 36 publications contained the keywords "blockchain and adoption" in the title and were directly relevant to answering our research questions (RQs). These publications were assessed based on their frequency of viewings, citations, and sharing to determine their importance [5].

A further search on the Elsevier Science Direct database for "sustainable blockchain" yielded 3413 results, with publication volume increasing from nine articles in 2016 to 1585 articles in 2021. Of these, 440 were reviewed publications. Upon reviewing these 440 results, we found that 40 publications included the keywords "sustainable blockchain" in the title and were directly relevant to our RQs. The importance of these publications was similarly assessed based on viewings, citations, and sharing [37]-[42].

However, most of these academic publications focus on industry-specific use cases such as healthcare, supply chain, aviation, banking, logistics, and IoT. An integrated adoption model that includes risk and success factors for fostering the sustainable adoption of blockchain technology across various industries was not available.

Our systematic literature review and empirical study successfully provided answers to the four research questions formulated in Section 2. Below, we present the results for each research question.

3.1. RQ1: In the Contexts of Business and Technology, How Is Adoption Established, and What Does It Mean?

Two critical aspects characterise the multi-faceted process of technology adoption in company innovation: maturity and acceptability. Users' positive attitudes and behavioural intentions towards a new method, product, or technology are crucial to its acceptance. Stakeholders' eagerness to integrate the innovation into their existing operations is shown in this [43]. Full operationalization, in which technology is thoroughly embedded into business procedures and evolves dynamically with ongoing operations, is represented by maturity, on the other hand [44].

To stay ahead in today's dynamic business environment, innovation is key. This includes coming up with new ideas, implementing them, absorbing them, and making the most of them in various social and economic contexts [45] [46]. It entails creating new production processes, launching novel management systems, and revitalising and growing products, services, and markets [47]. To maintain its influence and relevance, innovation must be consistently adopted and managed over time for businesses, as it is both an ongoing process and a transformative conclusion.

Understanding the factors that influence user acceptance or rejection of particular technologies and how these systems develop over time is crucial for stakeholders looking to activate and leverage innovations, especially in blockchain-driven business environments. Having this knowledge is essential for implementing success and risk variables that allow for a consistent method of operationalizing and managing innovative needs in a sustainable way. At every stage of a technology's lifespan, decisions are heavily influenced by factors like vision, interoperability, architecture, prices, governance, and agility [48]-[51].

To ensure that technology-driven innovations not only achieve early acceptance criteria but also mature into vital elements of new, authorized business practices, it is crucial to thoroughly evaluate the user experience throughout their adoption and maturation [36] [52]. Sustaining competitive relevance in ever-changing market landscapes is made possible by this strategic integration, which guarantees that technologies are not only embraced but also optimized and constantly managed.

3.2. RQ2: In Order to Address the Needs of Blockchain-Driven Company Innovation, What Hypotheses and Adoption Patterns Are Already Out There?

To successfully traverse the complexity and novelty of underlying technologies like blockchain, adoption strategies and models are essential. In order to successfully and sustainably deploy blockchain-driven business innovations, these models are crucial for understanding how technology breakthroughs attain acceptance and maturity. It is crucial to understand what drives stakeholders to accept or refuse new technologies since these factors impact their decisions about technological progress.

Having a firm grasp of the stages of innovation in technology is essential for efficient technology management procedures. In order to better manage the adoption of new technologies, this literature study systematically identifies numerous useful theories and adoption models. A few of these hypotheses and integrated models are listed in **Table 1**. They all provide different perspectives and frameworks for comprehending the dynamics of technology adoption.

The review covers a variety of models and theories, such as the following: capacity maturity model (CMM), theory of use and gratification (U&G), theory of diffusion of innovations (DOI), motivational model (MM), and theory of reasoned action (TRA). Additionally, it delves into integrated models like TAM + DOI and TAM + TPB, which stand for Technology Acceptance Models and Theories of Planned Behavior, respectively.

The purpose of this extensive analysis is to provide light on how to create a new adoption model that is optimal for long-term blockchain-driven company innovation. Organizations can better manage technological change and integration and make educated decisions on technology adoption if they have a firm grasp of these ideas and models.

Table 1. Models for adoption and theories.

References	Models and theories	Functions and parameters
[53]	Theory of reasoned action (TRA)	A trifecta of human cognitions: beliefs, personal standards, and behavioral intentions—used for behavior prediction
[54]	Diffusion of innovation theory (DOI)	To determine how quickly an innovation is adopted, we need to consider four factors: 1) the new idea itself, 2) means of communication, 3) time, and 4) the social structure. There are five criteria for innovation: 1) reliability, 2) relative edge, 3) difficulty, 4) trials, and 5) visible results
[55]	Motivational models (MM)	As far as technology adoption and use is concerned, there are two types of incentive: 1) extrinsic motivation and 2) intrinsic drive
[24]	Technology acceptance model (TAM)	A positive attitude towards utilizing, a behavioral intention to use (BI), and actual usage (USE) are the five two factors that determine the acceptance of technology in the IT profession
[44]	Capability maturity Model (CMM)	There are five stages to a process-based model's design: 1) early, ad hoc procedures; 2) repeatable; 3) defined; 4) controlled; and 5) optimizing. Integrating TAM with DOI Review the factors indicated as "DOI" and "TAM"
[56]	Integrated model (TAM + TPB)	Research the five factors that influence how people consider things to be easy to use: attitude, perceived usefulness, perceived behavioral control, and subjective norm

Martin Fishbein and Icek Ajzen laid the groundwork for the Theory of Reasoned Action (TRA) in 1967. It connects views, subjective norms, and behavioral intents. Attitudes towards the behavior and subjective standards—social influences that reflect economic, demographic, and societal factors—are said to determine behavioral intentions [57]. When it comes to understanding and forecasting human behavior in different settings, this theory has proved crucial.

The Technology Acceptance Model (TAM) expands upon TRA to further clarify how technology is accepted. Perceived utility (PU) and perceived ease of use (PEU) are the main factors that influence consumers' attitudes towards technological advancements, according to TAM, which was introduced to investigate users' acceptance and utilization of technology [58]. A user's PU has an effect on their BI when using a system, which in turn affects their actual utilization of the system.

In addition to TRA and TAM, Rogers' Diffusion of Innovation Theory (DOI) clarifies the social transmission of novel concepts and technology. Among the many aspects of innovation—its compatibility, complexity, communication channels, duration, and the social context in which it is adopted—are highlighted by DOI as critical determinants of adoption. To show how adoption has changed over time, DOI classifies adopters as creators, early supporters, early supporters, late supporters, or laggards.

Theoretically grounded in motivation, Motivational Models (MM) differentiate between the internal and external factors that influence people's decisions to accept new technologies. The pleasure that comes from utilising technology itself is an example of intrinsic motivation, whilst benefits like higher performance are examples of extrinsic motivation. Users' decisions to accept and use technology are influenced by numerous psychological motivations, which are highlighted by these models.

In addition, the Software Engineering Institute's Capability Maturity Model (CMM) provides a process-oriented way to evaluate and enhance organization's capacity to embrace innovations such as software processes. Organizations can enhance their procedures over time via organized evaluations and improvements guided by CMM's maturity levels, which range from initial to optimize.

In the realm of blockchain technology, maturity models have emerged to evaluate adoption readiness and manage associated risks. Models by KPMG and others assess factors like security, scalability, and interoperability across different stages of blockchain implementation. These models help organizations navigate the complexities of adopting blockchain by providing frameworks for strategic decision-making and risk management.

Understanding the processes of technology adoption in specific circumstances is enhanced by integrating TAM with DOI or Theory of Planned Behavior (TPB). Integrating TAM and DOI, studies such Wang, *et al.* [59] investigated what factors influence the adoption of technologies like blockchain, with a focus on trialability, relative benefit, and compatibility.

3.3. RQ3: How Can We Fill What Is Lacking in Our Understanding of the Adoption of Blockchain and the Technical Needs for Long-Term, Blockchain-Driven Business Creativity?

Our initial search revealed a limited number of publications related to the keywords "sustainable blockchain usage" and "blockchain adoption models." Furthermore, there is a notable absence of research and documentation on the impact of blockchain projects. This creates a significant gap in content that supports awareness, knowledge, implementation, scaling, and optimization of sustainable blockchain practices. The current body of literature fails to provide a comprehensive understanding of how blockchain technology can be sustainably integrated into business operations. This deficiency underscores the need for established standards and robust requirements management in this domain to ensure that blockchain

technology can be effectively and sustainably adopted.

At present, there is no universally applicable adoption model that can empower organizations and stakeholders to accelerate and manage blockchain-driven business innovation sustainably. This gap becomes evident when examining existing studies, which tend to focus on specific use cases such as healthcare, supply chain, aviation, banking, logistics, and IoT with certain criteria. These studies often capture only parts of the requirements engineering and innovation process, lacking a holistic approach. There is a clear need to design an integrated adoption model that can empower stakeholders across various industries and use cases to utilize blockchain technology for sustainable business innovation. Such a model should provide a comprehensive framework that addresses the unique challenges and opportunities presented by blockchain technology in different industrial contexts.

Another identified gap is the absence of a normative and consensus-generated framework of risk and success factors that can be embedded in an adoption model. This framework is essential to operationalize, measure, manage, and optimize requirements engineering for sustainable business innovation and operations. The current lack of a standardized framework means that businesses often struggle to identify and mitigate risks associated with blockchain adoption, which can hinder the successful implementation and scaling of blockchain projects. Developing such a framework would provide organizations with the tools and guidelines necessary to navigate the complexities of blockchain technology, ensuring that it is used effectively and sustainably.

There is a notable lack of applied projects and studies available to the community and all stakeholders interested in innovating business models and operations using blockchain technology. Given the distributed and decentralized nature of blockchain, it is crucial to provide a learning environment that accelerates blockchain-driven innovation across industries. More mature industries like gaming or finance could offer valuable insights to less mature industries. However, without sufficient applied projects and studies, the potential for cross-industry learning and innovation is significantly limited. Providing such resources would enable stakeholders to experiment with and refine blockchain applications, fostering a deeper understanding of how blockchain can be leveraged for sustainable business innovation.

While some studies on integrated adoption models combining the Technology Acceptance Model (TAM) with the Diffusion of Innovations (DOI) theory or the Theory of Planned Behavior (TPB) exist, further research and development initiatives are needed. These initiatives should support the active testing of these integrated models, particularly through industry-wide blockchain projects. There is a lack of efforts to merge existing adoption models to manage the aspects of novelty and complexity in the context of blockchain technologies. An integrated model addressing both aspects would be beneficial for a better understanding of acceptance and maturity as key factors in the blockchain adoption process within the realm of business innovation. By developing and testing such models, researchers

can provide valuable insights into how blockchain technology can be effectively adopted and integrated into business operations, promoting sustainable innovation across various industries.

3.4. RQ4: Which Innovative Adoption Strategy Can Operationalize Acceptance and Maturity Level Requirements to Empower Blockchain-Driven Business Creativity in a Sustainable Way?

For blockchain technology to be widely and sustainably used, it is essential to manage its complexity and novelty simultaneously. In order to tackle these issues simultaneously and fill in the gaps in the current research, we suggest a hybrid adoption model that merges the “Technology Acceptance Model” (TAM) and the “Capability Maturity Model” (CMM). This unified framework, called the “TAM + CMM Adoption Model,” is designed to help businesses innovate faster with blockchain technology. The decision-making process is impacted by user attitudes, values, and aspirations to adopt blockchain technology, which is why novelty is linked to acceptability in this context. On the flip side, complexity and maturity go hand in hand; they stand for the different ways in which people use and adapt new technologies in complicated settings. **Figure 1** shows the model, which provides a thorough framework to manage and accelerate blockchain adoption sustainably; it consists of seven x-axis levels and six y-axis levels.

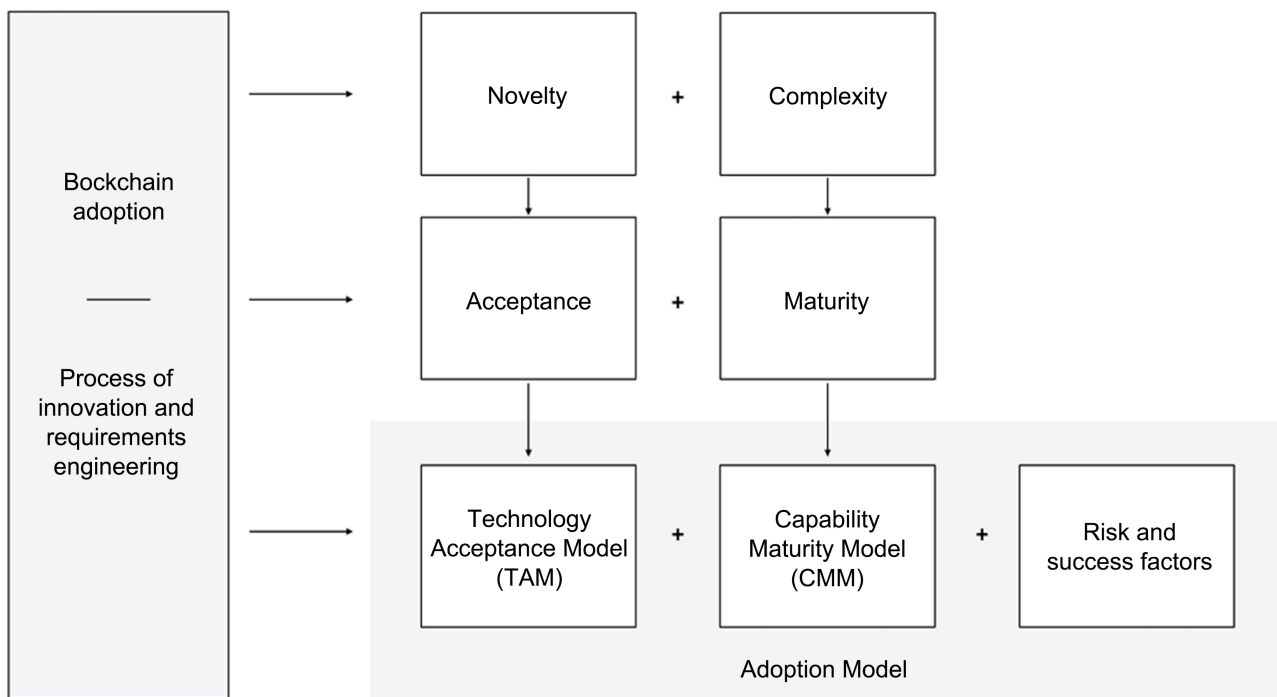


Figure 1. The newly integrated blockchain adoption model's conceptual framework.

With the addition of the “Level of Knowledge” (LK) and “Perceived Risk” (PR) parameters, the Technology acceptability Model (TAM) has been enhanced to offer a more thorough analysis of blockchain technology's acceptability. By incorpo-

rating thoughts on first-time exposure and individual doubts about the technology, these enhancements hope to shed light on the acceptance process.

Since it indicates the extent to which consumers are familiar with the technology, “Level of Knowledge” (LK) was included as a metric to gauge acceptability. What this means is that raising awareness of the technology’s benefits will require a significant amount of facilitation. The unpredictability of the results of choosing blockchain technology over alternatives is known as “perceived risk” (PR). When embracing new technology, users and stakeholders have certain expectations and objectives, and the degree to which they could be let down is a measure of perceived risk.

Also, the CMM has been updated to incorporate the new criteria “Awareness” (level 1) and “Knowledge” (level 2). In order to implement blockchain technology, it is necessary to be familiar with it. One factor that affects the rate of adoption is the level of knowledge about the technology. The model’s goal in include these elements is to provide a more comprehensive grasp of blockchain technology, its values, and the advantages it offers prior to project initiation. In order to simplify things and encourage a sustainable maturity process for requirements engineering, it is essential to educate stakeholders and raise awareness about blockchain technology, its risks, and the variables that contribute to its success.

Figure 2 illustrates the extended TAM parameters on the y-axis, which now includes six parameters in total. From top to bottom, these parameters for blockchain technology acceptance are defined as follows.

Capability maturity model (CMM)

	Awareness = level 1	Knowledge = level 2	Initiation = level 3	Implementation = level 4	Standardization = level 5	Scale = level 6	Optimization = level 7
Technology Acceptance Model (TAM)	Level of knowledge = LK						
	Perceived usefulness = PU						
	Perceived risk = PR						
	Perceived ease of use = PEU						
	Intention to use = BI						
	Active system use = ASU						

Figure 2. A tailored and integrated adoption model (TAM) and a customer relationship management system (CMM) to facilitate long-term, blockchain-powered company innovation. The X-axis represents the “Capability Maturity Model,” and the Y-axis represents the “Technology Acceptance Model” (TAM).

- **Level of Knowledge (LK):** The degree to which consumers understand blockchain technology. It is often believed that in order to embrace a technical system, one must have some understanding of it.
- **Perceived Usefulness (PU):** A measure of the incentive to embrace and make use of blockchain technology. People won't adopt and make use of technology if they don't think it will benefit them.
- **Perceived Risk (PR):** The amount of user-perceived ambiguity about blockchain technology's acceptability. A user's "perceived risk" is the chance that blockchain technology might fall short of their expectations.
- **Perceived Ease of Use (PEU):** A critical aspect that determines sustainable acceptance and implementation of blockchain technology. If people don't think a system is easy to use, they won't adopt it. "Perceived ease of use" assesses the technology's operability or user-friendliness, whereas "perceived usefulness" focuses on the technology's significance.
- **Behavioral Intention to Use (BI):** It all comes down to how hands-on people are willing to get with blockchain technology. This shows that you have a well-defined goal and are halfway through the acceptance process.
- **Actual System Use (ASU):** This term describes a feature of the technology that is now in use. This shows how widespread the acceptance is. An acknowledged system is one that is currently in use.

Seven stages of blockchain adoption have been defined by us based on our adaptation and extension of the classic Capability Maturity Model (CMM). The stages are as follows: understanding, awareness, beginning, execution, standardisation, scalability, and optimisation. The first level is awareness, which means that people are aware of blockchain technology. The technology gains more and more recognition as awareness increases. Beyond mere awareness, stakeholders and users who have made an effort to learn about blockchain technology and its potential benefits and drawbacks are considered to have achieved knowledge. Acquiring this thorough understanding is vital for enabling stakeholders to launch initiatives and successfully oversee innovation driven by blockchain.

By integrating blockchain technology into preexisting company processes, initiation signifies the commencement of the innovation process. To steer these early initiatives, stakeholders use what they know about the dangers and potential rewards of blockchain technology. When initiatives reach the implementation stage, they start making a difference and change people's attitudes, behaviours, business models, and operations for the better. Risk and success considerations drive maturity development criteria, which steer these changes. There is a lot of development and the establishment of best practices when a project reaches the standardisation phase after implementation, during which new operations can be tested and new standards are created.

The scale level signifies that blockchain adoption has reached a mature and widely recognised state, as it entails growing the innovation to reach bigger user groups inside operations. At its pinnacle, optimisation seeks to maximise efficiency

and utility by iterative refinement. Sustainable blockchain adoption for corporate innovation can be achieved by implementing the “TAM + CMM Adoption Model,” which allows us to operationalize, measure, and control the process. All levels of maturity should be considered while using this model, as it stresses the significance of risk and success elements. Failures, drains on resources, and diminished competitiveness are the results of ignoring these elements. Thus, they play an essential role in navigating the complexity and newness of blockchain technology, boosting adoption rates, and progressing through the adoption maturity levels.

Some success and risk variables for blockchain adoption management are applicable across all blockchain applications, while others are application-specific. There is still no consensus taxonomy of blockchain success criteria, despite a mountain of literature on the topic. On the other hand, many people believe that blockchain adoption will only be effective if specific conditions are met, such as scalability, performance, governance, security, and change management. Eight areas where risks should be considered have been identified by the consulting firm KPMG: management of access and users, authorization and provisioning, data, interoperability, performance, change, privacy, and security.

These are the most important topics to focus on to ensure long-term innovation in a company and to manage blockchain adoption. To manage the unique and complex aspects of blockchain technology, it is crucial to address these risk considerations. Failures may result from disregarding or ignoring these elements, which can have a severe effect on resources and market competitiveness. Consequently, the adoption of blockchain technology must progress in maturity levels and acceptance rates, and these success and risk elements must be understood and managed thoroughly.

4. Discussion

The research questions that were stated were answered by our data; however, it is important to analyze these answers and conclusions in their proper perspective.

Our research shows that, in relation to RQ1, adoption is best viewed as an innovation process, with critical steps revolving around novelty and complexity. These features are associated with maturity and acceptance. Although both are essential for blockchain acceptance, additional factors could help build a complete model for blockchain adoption. To successfully traverse the complexity and novelty of this core technology for company innovation, it is essential to incorporate pertinent elements like maturity and acceptance.

In response to RQ2, we compiled a list of potential theories and models for incorporating key features into a new blockchain adoption model, which would allow stakeholders to make more long-term use of blockchain technology for company innovation. Given the high likelihood of failure in blockchain adoption, it is clear that we need to incorporate elements like maturity and acceptance.

Research on blockchain adoption models, especially the explicit operationalization of such models, is in its infancy and necessitates further investigation,

according to the examination and identified gaps in the framework of RQ3. The lack of a standard, widely applicable adoption strategy that can enable businesses and organizations to handle blockchain-driven innovation more effectively and efficiently makes this requirement very clear. The reviewers noticed that each source only covers one use case with one set of criteria, or that current models and theories only cover part of the requirements of engineering for innovation, thus they knew there was a gap. It is evident that there is a need for a unified adoption model that can enable stakeholders in any sector to leverage blockchain technology for long-term company innovation.

An incorporated blockchain adoption model for sustainable business innovation can be designed using the theories of “TAM” (Technology Acceptance Model) and “CMM” (Capability Maturity Model), which were examined in the answers to RQ1, RQ2, and RQ3. This opportunity was presented in RQ4 as a result of these analyses. Given the many stages of user evolution in complex innovation environments and the need to incorporate user attitudes, values, and intentions, we argue that an integrated approach to managing complexity and novelty is essential for the sustainable, industry-wide adoption of blockchain technology. To operationalize, assess, manage, and optimise requirements engineering for business innovation and operations in a sustainable fashion, it is apparent that risk and success elements must be integrated into such an adoption model. The “TAM + CMM Adoption Model” is a crucial tool for operationalizing, measuring, and managing the associated side effects of blockchain project failure rates. These effects have a negative impact on economic and social sustainability and can be seen in areas such as corporate governance, risk management, finance management, human resources, culture management, and competitiveness.

Although we think our findings hold water, there are a few caveats we’d like to address. Our findings provide a picture of the evolution up until December 2021. Nothing here represents ongoing projects that have not been published just yet, or anything started either during or after we started our research. Further, as of this writing, private commercial studies may have been undertaken by consulting companies. To validate the “TAM + CMM Adoption Model,” we intend to solve some restrictions, such as the requirement for ongoing case studies and further industry initiatives. At the moment, we are arranging these industry-wide case studies in a way that takes into account the integration of all the risk and success factors that have been provided across the “TAM” and “CMM” levels.

One aspect of our future study will be post-pandemic studies that aim to determine the current level of blockchain adoption in different industries or to zero in on a certain industry that is particularly important for business innovation. A stimulus for the quick adoption of technology, the repercussions of the global pandemic response are influencing basic social standards. It will be fascinating to compare data before and after the pandemic. For these next studies, we have settled on the cultural and creative business as a possible target. We will use these findings to think about ways to make the “TAM + CMM Adoption Model” more

applicable to levels of maturity and additional TAMs.

5. Conclusions

Blockchain technology is increasingly recognized as a pivotal driver of business innovation, as evidenced by high levels of awareness. Despite this recognition, there remains a notable decline in Technology Acceptance Model (TAM) parameters—such as the level of knowledge, perceived usefulness, perceived ease of use, intention to use, and active system use—across various Capability Maturity Model (CMM) maturity levels, irrespective of industry sector or company size. This indicates a significant gap in effectively managing blockchain adoption sustainably. Through descriptive and empirical analyses, it has been demonstrated that the integration of TAM and CMM into a cohesive “TAM + CMM Adoption Model” provides a robust framework for assessing acceptance and maturity levels of blockchain technology. The high survey closure rate of 98.5% underscores the model’s applicability and reliability, suggesting that it can facilitate the sustainable use of blockchain for business innovations across diverse industries and applications, including business models, products, services, and supply-chain management.

The integration of TAM and CMM offers several critical benefits for business innovation. Firstly, it enables simultaneous analysis and management of the dimensions of novelty and complexity, which are inherent in emerging technologies. Secondly, it addresses acceptance and maturity as essential factors throughout the innovation process, providing a dynamic approach to managing associated risks and success factors. By observing acceptance levels at each maturity stage, the model helps manage and mitigate risks at appropriate phases of the innovation process, thereby enhancing the sustainability of blockchain adoption. Furthermore, the TAM + CMM Adoption Model is technology-agnostic and can be applied to other emerging technologies like nanotechnology, AI, robotics, virtual reality, and the metaverse. This adaptability underscores its potential as a tool for operationalizing, measuring, and managing innovation processes across various industries and use cases. Developing a software-as-a-service (SaaS) application based on this model could further empower businesses to optimize their innovation strategies and foster community development through shared insights and collaborative growth.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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