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Strategies for Supporting Blockchain Technologies to Enable Resilient Systems

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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Walden University
2023

Abstract

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MS, University of Virginia, 2013

BA, University of Richmond, 2009

Doctoral Study Submitted in Partial Fulfillment

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Abstract

Blockchain technology is regarded as a transformative force in numerous industries and a pivotal innovation of the 21st century. The failure to adopt blockchain technologies can lead to increased resiliency events for information technology (IT) systems. The potential losses from resiliency events can be highly significant, with hourly costs of IT service outages ranging from hundreds of thousands to millions of United States dollars. Grounded in change management theory, the purpose of this qualitative multiple-case study was to explore strategies IT professionals use to support blockchain technologies to enhance system resilience. The participants were 4 IT professionals working in the United States with 8 years of experience supporting enterprise systems and blockchain technologies. Data were gathered through semi-structured interviews and an examination of organizational documents. The data were analyzed using thematic analysis, and three themes emerged: decentralization, privacy, and transaction speed. The key recommendation is for IT leaders to understand decentralization, its impact on resiliency and transaction speeds, and what type of data should be placed in blockchain technology when considering privacy and data availability. The implications for positive social change include the potential to reduce downtime in critical IT systems, including hospital systems, essential supply chains, and utility services, thereby contributing to more excellent operational stability.

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Dedication

I dedicate this study to my family, who supported me through this journey. Throughout this journey, I often leaned on my wife to give me the strength to move on. She did not doubt that I would accomplish this goal, which gave me the strength to move forward.

Acknowledgments

Thank you, Walden faculty, for pushing me harder than I have ever experienced. The feedback given in every assignment has built me into the resilient academic I also wanted to be. Thank you, Doctor Carpenter, Doctor Igonor, and Doctor Phillips, for the insight and patience you have offered and instilled in me.

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Section 1: Foundation of the Study

Background of the Problem

Many leaders and technology professionals view blockchain as the next significant technological advancement after the internet. Blockchain is a shared, decentralized, secure, and unchangeable digital ledger that brings increased trust and efficiency to business networks (Weber, 2018). Some popular cryptocurrency technologies that run on blockchains include Bitcoin and Ethereum. Enterprise blockchains are hailed as the key to secure and transparent processing of complex transactions within and between organizations (Goldsby & Hanisch, 2022). The resiliency of these distributed networks is one of the benefits many technologists wish to explore within existing platforms. The potential losses from downtime include hourly costs of information technology (IT) service outages ranging from hundreds of thousands to even millions of U.S. dollars (Wang & Franke, 2020). With the potential resiliency that blockchain technologies can offer existing platforms, IT professionals must have a solid understanding of the strategies needed to support these technologies, especially in health care and supply chain systems. In this study, I explored the strategies enabling IT professionals to use blockchain technologies to support system resiliency.

Problem Statement

IT professionals are responsible for ensuring resiliency within the platforms that they support. However, the existing technologies that organizations use are still resulting in outages. For example, the U.S. economy had a US$ 20-55 billion loss due to severe weather-related outages from 2003 to 2012 (Taimoor et al., 2020). When considering the types of systems that could benefit from the resiliency built into blockchain technologies, the health care sector suffers from inefficiencies in data handling due to resiliency and data sharing between organizations (Alzahrani et al., 2022). The general IT problem that prompted me to search the literature is that many organizations lack strategies that enable IT professionals to use blockchain technologies to support system resiliency. The specific IT problem is that some IT professionals lack strategies to support blockchain technologies to enable resilient systems.

Purpose Statement

This qualitative, multiple case study was conducted to examine the strategies IT professionals use to support blockchain technologies to enable resilient systems. The population group of this study is IT professionals in the blockchain industry from the development and infrastructure teams within the United States. The findings from this study may benefit organizations by showing examples of resiliency gaps within existing IT systems and the potential to use blockchain technology to mitigate the risk. This may also indicate the need for business leaders to build a resilient IT architecture that addresses the potential gaps in the IT infrastructure and processes. Social change includes reducing the downtime of vital information technology platforms, such as hospital systems, critical supply chains, and utility services. Social change may also involve shifts in consumer behavior, evolving societal expectations, changes in regulations and policy, or emerging technological trends and innovations.

Nature of the Study

When considering the appropriate research method, I looked at qualitative, quantitative, and mixed methods. I thought of these approaches in the context of my study. As a result of my analysis, I determined that a qualitative research method was the best fit for my study. This approach has a rich history of helping researchers appreciate revelatory cases, build grounded theories, and coin new concepts to describe emerging phenomena (Monteiro et al., 2022). When harnessed to their full potential, qualitative research methods support theorizing, the problematization of rigid or engrained ways of thinking, questioning of taken-for-granted knowledge, exploration of little-known phenomena, samples, or context, and co-creation of learning and sense-making, among many other purposes (Köhler et al., 2022). In other words, engaging qualitative methodology allows for expanding the field with research questions that are more general and open than adjusting the emerging story throughout data collection as new information comes forward (Clare, 2022). In contrast, by integrating qualitative and quantitative procedures, mixed methods research offers the power of numbers and stories for investigating complex social and behavioral questions (Hou, 2021). Mixed-method research is a quantitative methodology that requires countable research objects, whereas qualitative methodology describes and interprets its research objects (Stoecker & Avila, 2021). I chose a qualitative study over a mixed method study because it allowed for a deeper, more detailed exploration of the subjective experiences and meanings, which were critical for understanding the nuances of the research problem.

I chose a multiple case study as the most appropriate for my research topic. A case study is used to explore a real-time phenomenon within its naturally occurring context, considering that context will create a difference (Stoecker & Avila, 2021). The case study approach facilitates the investigation and understanding of the underlying principles in the real-world phenomena involved in constructing the future vision in the backcasting study (Aalbers et al., 2020). The case study design supports my research goals because I intended to understand the resiliency practices of IT professionals.

I also considered other qualitative approaches like ethnography, phenomenology, and narrative research. The ethnography approach is used to explore complex cultural norms and phenomena through long-term engagement in the field of research (Andreassen et al., 2020). My research focused on IT professionals' experience supporting resilience, which is unrelated to cultural norms. Additionally, phenomenology focuses on the experiences of individuals, but I was not focused on the lived experiences but rather the resiliency practices of IT professionals. The narrative design systematically codes individual differences in how they tell their stories about significant life events to understand how they create meaning and purpose (Grysman & Lodi-Smith, 2019). My study did not focus on an individual's life but on their professional technology experience.

Research Question

What strategies do IT professionals use to support blockchain technologies to enable resilient systems?

Interview Questions

1. What is your current role with your company?
2. How significant is IT resiliency to your company?
3. How does your current role contribute to resiliency?

4. Are you familiar with distributed blockchain networks?
5. Are you familiar with the concepts of smart contracts on blockchain networks?
6. What are resiliency issues you have encountered in the past?
7. What are your responsibilities when a resiliency event occurs?
8. What are the impacts of these resiliency events?
9. How do you think blockchain platforms can resolve these resiliency issues?
10. Why do you think these resiliency events occur?
11. What type of architecture is used within these platforms to enable resiliency?
12. Why would you consider or not consider blockchain technology a solution to resiliency issues?
13. What procedures should organizations consider when migrating to blockchain technologies?
14. Are there any other thoughts you have on this topic?

Theoretical or Conceptual Framework

The conceptual framework I applied to my study was the change management (change iceberg) theory, developed by Kruger. The logical connections between the framework presented and the nature of my study include the challenges IT professionals face when adopting new technologies within organizations, such as blockchain. It requires massive organizational changes to adopt new technologies like blockchain. This change must be initiated at the top of leadership to profoundly alter the organizations' underlying technologies and directly impact the management of perceptions and power and politics management (Kruger, 2022). In this context, leadership is crucial in addressing overt challenges and instigating and sustaining transformative shifts in values and principles, ensuring successful adoption and alignment with the new technological paradigm (Bedrii, 2020). Within this submerged domain, leadership emerges as a pivotal force, with the meticulous orchestration of the overt technological transition and the concurrent management of subterranean shifts in organizational perceptions and politics. Within this underlying layer, comprised of attitudes, fears, and organizational culture, significant challenges to, or facilitators of, technological adoption reside. One of the key benefits of blockchain technology could be the resiliency they build into systems. However, IT professionals will need to have strategies to support blockchain technologies, and this may only be accomplished by leadership influence from the perspective of management of perceptions and power and politics management.

Definition of Terms

Blockchain: Blockchain is a linked arrangement of records, called blocks, each block stores the previous block's hash, timestamp, and transactions, and the instance of linked blocks are replicated on every node in a network (Sreenu et al., 2022).

Bitcoin: Bitcoin blockchain application is a public peer-to-peer payment application that stores the transaction history on a digital blockchain database and is independent of an intermediary, such as a national bank (Mattke et al., 2021).

Cryptocurrencies: A digital cash that uses cryptography to secure its transactions and verify the transfer of digital assets through blockchain and over the internet without using a centralized banking system (Andriole, 2020).

Digital ledger: A record of transactions maintained by consensus among a network of peer-to-peer nodes that may be geographically dispersed (Kuhn et al., 2019).

Ethereum: Ethereum is the successor to Bitcoin and is a decentralized, censorship-resistant, incorruptible platform that runs on smart contracts (Sabalionis et al., 2021).

Smart contracts: Smart contracts are deterministic computer programs that may be invoked when a transaction is recorded on the blockchain, affecting the transaction's outcome (Neiheiseret et al., 2023).

Assumptions, Limitations, and Delimitations

Assumptions

Assumptions are some aspects of a topic or research that do not have evidence of validity (Helmich et al., 2015; Hufford, 1996). In this study, I assumed the IT professionals I interviewed have experience supporting infrastructure and developing applications within blockchain technologies. This experience would lead to lessons on how they enabled resiliency in these platforms. I also assumed that they would participate in a 1-hour interview and know existing strategies to increase resiliency in systems. Another assumption I made is that companies would grant me access to documentation showing resiliency strategies in their organizations.

Limitations

When considering assumptions, researchers usually have control over this aspect. However, with a limitation, the researcher does not have control, which may directly impact the study. Limitations of any study concerned potential weaknesses that were usually out of the researcher’s control and were closely associated with the chosen research design (Theofanidis & Fountouki, 2019). One of the risks of a qualitative study is that some participants might have answered the interview questions in a manner that pleased the researcher, which is considered a limitation in case study research (Yin, 2014). Since I performed a multiple case study with four participants, this was a limitation because I might not have obtained enough research data.

Delimitations

The use of delimitations in my study ensured that my research was focused while also reinforcing my objectives. Delimitations are the boundaries or limits of a researcher’s work so that the study’s aims and objectives do not become impossible to achieve (Theofanidis & Fountouki, 2019). One of the delimitations in my study was that I only performed four cases with IT professionals from the development and infrastructure teams. These IT professionals had experience supporting enterprise applications and were restricted to the United States. Another delimitation was that the IT professionals were required to have at least eight of experience supporting enterprise applications with blockchain experience. I explored IT professionals’ strategies to enable resilient systems.

Significance of the Study

Contribution to Information Technology Practice

This study was significant because the results provide examples of resiliency gaps within existing IT systems and the potential to use blockchain technology to mitigate the risk. The results indicated the need for business leaders to build a resilient IT architecture addressing potential IT infrastructure and processes gaps. This led to support strategies for blockchain technologies to enable resilient systems and boosted the body of knowledge within organizations.

The change management theory, often called the change iceberg, underscores the importance of looking beyond the apparent, superficial aspects of organizational change. Though the observable changes—like those within executive leadership—are usually measured in cost, quality, and time, the theory posits that deeper, hidden aspects play a critical role in successful change implementation. These less visible facets, which include shifts in teams' behaviors and values, can significantly influence the redistribution of power and political dynamics within the organization. This understanding is crucial, especially when considering the adoption of novel technologies like blockchain, which promises operational efficiency and demands a transformation in underlying organizational culture and values. Grounded in Kruger's change management principles, organizations can navigate the multifaceted challenges of change, ensuring surface-level and profound adjustments align for greater resilience (Bedrii, 2020).

Implications for Social Change

This study provides best practices for supporting resilient platforms using blockchain technology. Some of the industries that could benefit from this enhanced resiliency include health care, vital supply chains, and utility services. For instance, securely storing personal health information is crucial to ensuring patients receive quality care in health care settings. Blockchain technologies could lead to more resilient platforms as the technology is distributed across numerous nodes within an organization. Personal health records could be securely shared among various organizations, resulting in higher care since health care providers can access a complete patient history. Patients and health care organizations are frustrated by the multiple obstacles in obtaining current, real-time patient information (Alzahrani et al., 2022).

Another industry that could benefit from the resiliency of blockchain technology is critical supply chain systems. One example of such a system is a vaccine delivery network for medical facilities. These supply chain systems necessitate the transportation of vaccines in temperature-controlled vehicles. Blockchain technology could help ensure vaccines are delivered on time over vast areas, such as the United States. According to the Department of Health and Human Services, 7 billion people require, on average, one to two doses, totaling 15 billion doses for equitable distribution worldwide (Wang et al., 2020). Amidst this, vaccine wastage amounts to 20 to 30 percent due to cold storage and logistics disruptions during transit (Gupta et al., 2022). The social impact highlights the importance of the resiliency of critical data used in health care and critical supply chain management systems, as well as the potential for public blockchains to facilitate reliable data retrieval, ultimately benefiting society as a whole.

A Review of the Professional and Academic Literature

In gathering the critical literature for this study, I considered the technology of blockchain and the objective of using blockchain to increase resiliency in existing applications. This led me to focus on two important keywords: blockchain and resiliency. Utilizing these keywords, I collected relevant literature from various sources, including the Walden University Library, Google Scholar, OpenAI, and references from other academic papers. I focused primarily on peer-reviewed journal articles published within the last 5 years. However, there were instances in the research when I referred to books within the Walden University curriculum and articles older than 5 years to provide a clear, foundational understanding of a concept rather than to examine a phenomenon within business or technology. This comprehensive approach to literature gathering ensured a well-rounded knowledge of the subject matter and provided a solid foundation for further analysis and discussion.

In total, I collected 161 articles and 14 books for the literature review, of which 148 were peer-reviewed articles, using the Ulrich search engine to verify their authenticity. As stated earlier, my primary key terms were resiliency and blockchain. Numerous articles focused on one of the topics but not necessarily both within a single work. More broad terms used to find relevant articles included *change management theory*, *downtime*, *change iceberg*, and *strategies*. To refine the search, I employed these terms: *blockchain applications*, *enterprise platforms*, *project management*, *support*, *IT support*, *operations*, *organizational strategy*, and *outages*. While searching with these terms, I identified a recurring theme: Organizations had to change the underlying technology to address weaknesses within enterprise platforms. This theme was prominent within the health care, supply chain, and utility industries, where system uptime is crucial for meeting user needs. The overarching theme discovered within these articles is that current enterprise systems are not adequately addressing users' needs in terms of resiliency, and IT professionals lack the strategies to support new technologies that could potentially resolve this issue. This insight highlights the importance of developing effective strategies and embracing innovative technologies to enhance resiliency across various industries.

This literature review allowed me to examine existing enterprise systems and the ways in which IT professionals support these systems from both development and infrastructure teams' perspectives. Drawing on my experience supporting applications from an infrastructure standpoint, I ensured that the strategies discussed were viable and executable within an enterprise organization. The literature review is divided into three sections. The first part delves into the change management theory and the adoption of new technology, the second part offers an overview of blockchain technology and its existing applications, and the third part investigates current resiliency practices and how blockchain could enhance resiliency. These three sections collectively address the change management theory and its potential role in driving organizational changes toward utilizing blockchain technology to support resilient systems. This comprehensive analysis demonstrates the significance of understanding and adopting new technologies, such as blockchain, in strengthening the resiliency of enterprise systems in various sectors.

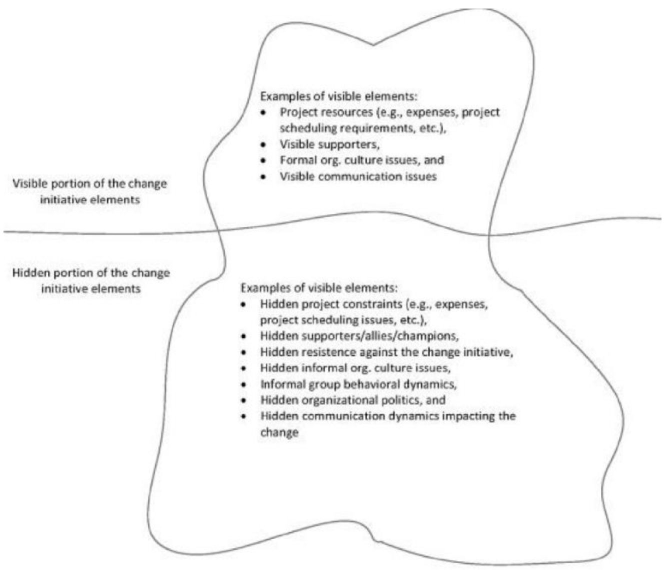
Change Management Theory and Organizations

The change management theory, also known as the change management iceberg, was initially proposed by Kruger (Bedrii, 2020). According to F. Kruger's observations, many project managers focus primarily on the visible part, overlooking the fact that the main levers of political power, project constraints, and group dynamics do not lie on the surface (Bedrii, 2020). The surface level encompasses the management of costs, quality, and time. In contrast, at the deep control level, management of changes and implementations occurs, including perceptions and culture, power, and political dynamics. Fundamental changes necessitate profound shifts in team members' behavior and values, which, in turn, affect the redistribution of power. A fuzzy evaluation approach, integrated into the change management process, can effectively navigate the subtleties and the "hidden" elements beneath the project's surface (Cragg & Chraibi, 2020; Vlasenko et al., 2019). By incorporating such nuanced assessment techniques, project managers can gain a more comprehensive understanding of the factors influencing the success of change initiatives, thereby improving their ability to manage complex projects.

Kruger's change management theory is a valuable framework for understanding and managing change within organizations. By considering both the visible and hidden aspects of the iceberg, organizations can develop more effective change strategies and enhance the likelihood of success. This comprehensive approach to change management can help organizations adapt to new challenges, improve overall performance, and foster a culture of continuous improvement and growth. Figure 1 illustrates the surface and hidden layers of the change management theory iceberg, as depicted by Leflar (2021).

Figure 1

Change management theory Iceberg

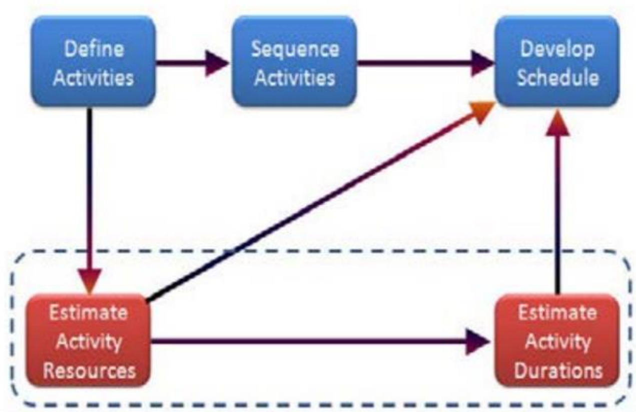


Note. From "Change Management for Risk Professionals," by J. Leflar,. Copyright 2021 CRC Press.

The three aspects of the change management iceberg visible to leadership and project resources are time, cost, and quality. Time schedule control in projects is often perceived as activities carried out at the beginning of a project with limited information that can accurately predict each detailed activity's duration (Fewings & Henjewele, 2019). The time aspect is tracked when determining the progress of an initiative or project. Further, time management is a cluster of behavioral skills essential for the organization regarding project execution; empirical evidence suggests that effective time management is associated with strategies that allow individuals to negotiate competing demands (Adams & Blair, 2019). Time management can also be described as the self-organization of people toward successful career development and identifying opportunities and ways of self-organization for initiatives (Gladkova & Gordeev, 2022). Furthermore, time management does not require a person to learn to do as many things as possible in a short period, but it instead ensures that the person does what needs to be done, addressing the issues that require attention (Bucata et al., 2021). These interpretations of time management consider the behavioral aspects of completing either a project or an initiative. Though these elements of time may be necessary for the success of a project, it is important to balance competing aspects such as communication and project resources. Adopting a holistic approach to time management can help organizations enhance their productivity and optimize resources. Figure 2 illustrates the process of time management and the interpretation of requirements (Bucata et al., 2021):

Figure 2

Time Management Process



Note. From "Time Management: The Basic Concern in the organization," by G. Bucata, A. Rizescu, L. & Barsan, 2021, *Journal of Defense Resources Management, 12*(2), p. 14.

Quality is another aspect visible on the surface within the change management theory. Quality can be defined as the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs; in simpler terms, quality refers to “fitness for use” or “meeting or exceeding customer expectations” (Kerzner, 2017). Quality can also be described as the process of ensuring that the project delivers the expected results and meets the requirements and expectations of the stakeholders (Mishra et al., 2020). Maintaining high-quality standards is essential for the successful implementation of projects, as it contributes to stakeholder satisfaction and the overall value of the project outcomes. Furthermore, quality management in projects often involves setting clear objectives, establishing suitable processes, and continuously monitoring and improving performance. By prioritizing quality, organizations can minimize risks, reduce costs, and enhance their reputation in the long term, ultimately leading to more successful projects and satisfied stakeholders.

The final aspect on the surface of the change management theory iceberg is cost. Cost management encompasses the processes required to ensure a project is completed within the approved budget, which includes resource planning, cost estimation, budgeting, and cost control (Project Management Institute, 2017). In the context of the change management theory, understanding and managing project costs is essential for successfully implementing change initiatives within organizations (Krueger, 2017). Effective cost management can help organizations minimize risks associated with project overruns and enhance overall efficiency in the change process (Kerzner, 2017). Visible cost elements, such as labor, materials, and equipment, are relatively straightforward to quantify and manage. However, hidden cost elements, such as the impact of change on organizational culture, power dynamics, and employee morale, can be more challenging to measure and control (Leflar, 2021). Organizations should be aware of the change process's potential direct (e.g., personnel, technology) and indirect (e.g., lost productivity, turnover) costs when implementing change initiatives (Mishra et al., 2020). To effectively manage project costs concerning the change management theory, organizations should adopt a comprehensive approach that considers both the visible and hidden aspects of change:

1. Establish a realistic project budget: A well-defined budget should consider the direct and indirect costs of the change initiative, including the potential impact on organizational culture and employee morale (Project Management Institute, 2017).
2. Implement effective cost control measures: Regular monitoring and control of project costs can help organizations identify potential issues early in the change process, enabling them to take corrective action and minimize the risk of cost overruns (Kerzner, 2017).
3. Engage stakeholders in the change process: By involving stakeholders in the development and implementation of change initiatives, organizations can foster a sense of ownership and commitment, which can help reduce resistance to change and minimize indirect costs associated with employee turnover and lost productivity (Zacharias et al., 2021).
4. Foster a culture of continuous improvement: Encouraging continuous learning and progress can help organizations identify opportunities for cost

optimization and enhance overall efficiency in the change process (Mishra et al., 2020).

By adopting a comprehensive approach that considers the visible and hidden aspects of change, organizations can better manage project costs, minimize risks, and enhance overall project success.

In addition to time management, quality, and cost, the hidden layer of the iceberg comprises cultural issues within an organization. Culture is a unique characteristic of human groups created to fulfill the basic need for finding shared meanings of events (Zacharias et al., 2021). Organizational culture is a pattern of basic assumptions invented, discovered, or developed by a given group (Duan et al., 2023). As the group learns to cope with its problems of external adaptations and internal integration, that approach has is taught to new members as the correct way to perceive, think, and feel about these problems. This aspect of change management theory can be crucial to the success of a project or initiative within an organization. However, some leaders and project resources may not understand what makes a project or initiative successful. The leading causes of project failures include lack of commitment by top management, resistance to change, inadequate rewards and recognition mechanisms, inconsistent monitoring and control of the projects, and poor communication (Antony et al., 2022). Despite meeting cost, time, and quality criteria, projects can still suffer from stakeholder dissatisfaction, misaligned expectations, and limited benefits realization (Atkinson, 1999). Organizations must recognize the importance of addressing cultural issues and fostering a positive work environment, which can contribute significantly to successfully implementing change initiatives and overall performance.

Change Management Theory and Information Technology

Change management theory may be a critical aspect of successful Information Technology (IT) implementation, as it assists organizations in navigating the complex process of adopting new technologies. Effective change management practices consider the human factor and organizational dynamics, recognizing that technology adoption is not merely a technical process but also involves shifts in corporate culture and individual behaviors (Madsen et al., 2020). As explained by Špundak & Šeric (2019), change management practices are essential for achieving desired results in IT implementation, as they address the people side of change, helping to overcome resistance and fostering a positive attitude towards new technology.

Adopting new technologies may require a comprehensive understanding of the interplay between various factors, such as user acceptance, training, and support. Technology Acceptance Model is a widely used framework to explain how individuals accept and use new technologies, emphasizing perceived usefulness and ease of use as the primary determinants of technology acceptance (Tarhini et al., 2021). Employing TAM within the context of change management theory can help organizations identify potential barriers and enablers to technology adoption, enabling them to design targeted interventions that facilitate a smoother transition to new IT systems (Hosseini et al., 2020).

In a study by Tiron-Tudor et al. (2021), this fusion of agile change management principles and change management theory is further explored in the context of accountancy organizations implementing blockchain technology. Their systematic literature review underscores the importance of agile principles in managing change, particularly in navigating the complexities of adopting cutting-edge technologies such as blockchain. They echo Denning's (2020) perspective on the value of cross-functional teams, iterative planning, and continuous feedback loops, emphasizing how these principles foster a culture of learning, adaptation, and innovation. Their findings suggest that by integrating these agile principles with change management practices, accountancy organizations, and potentially others, can better align technology implementations with strategic goals, enhancing the overall effectiveness and value of such initiatives.

Change management theory may be crucial in successful IT implementation by helping organizations navigate the complexities of adopting new technologies. It addresses technology adoption's human and organizational aspects, focusing on overcoming resistance and fostering a positive attitude towards new technology. The technology acceptance model can be employed within the change management theory context to identify barriers and enablers to technology adoption, allowing for targeted interventions and smoother transitions to new IT systems. The agile approach to change management has gained prominence in IT for its flexibility and responsiveness to evolving technology and market demands, emphasizing cross-functional teams, iterative planning, and continuous feedback loops. By integrating agile principles with change management theory, organizations can successfully adopt new technologies while aligning with strategic goals and enhancing IT implementation effectiveness.

Supporting Theories

To better understand the change management theory by Kruger, let's discuss some supporting theories. The first supporting theory is Lewin's change management Model. Kurt Lewin's model emphasizes three main stages of change - Unfreeze, Change, and Refreeze (Islam, 2023). The model emphasizes the need to prepare an organization for change, implement the difference, and solidify the organizational culture shift (Islam, 2023). Lewin's Change Management Model posits that successful change occurs by unfreezing the existing equilibrium, moving to a new state, and then refreezing the system in the desired shape, embedding the change within the organization's structures, processes, and culture (Serrat, 2017). In the context of organizational change, Lewin's model of change has been widely used as a basis for understanding change processes and designing change interventions (Bărbulescu & Boitan, 2019). Lewin's Change Management Model and Kruger's change management theory share similarities in their organizational approach to managing change. Both theories emphasize the importance of addressing barriers to change and recognizing that change is a process that requires attention at different stages. As this relates to adopting new technologies such as blockchain in an organization, it may be vital to address the barriers above with these two frameworks to change the enterprise applications.

Another theory similar to the change management theory by Kruger is Kotter's 8-step change model. This theory offers a step-by-step approach to managing organizational change. The eight steps include creating a sense of urgency, forming a powerful coalition, creating a vision for change, communicating the vision, removing obstacles, creating short-term wins, building on the change, and anchoring the change in the corporate culture (Haas et al., 2019). A well-known change management model is Kotter's 8-Step Change Model, which includes: (1) creating a sense of urgency; (2) forming a guiding coalition; (3) creating a vision and strategy; (4) communicating the change vision; (5) empowering broad-based action; (6) generating short-term wins; (7) consolidating gains and producing more change; and (8) anchoring new approaches in the culture (Raineri, 2017). According to Ali et al. (2020), Kotter's 8-Step Change Model is a widely recognized framework for implementing organizational change. Below is a figure of Kotter's 8-Step Change Model from Laig and Abocejo (2021).

Figure 3

Kotter's Eight Step Change Model

Note. From "Change Management Process in a Mining Company: Kotter's 8-Step Change Model," by R. B. D. Laig & F. T. Abocejo, 2021, *Journal of Management, Economics, and Industrial Organization*, *5*(3), p. x.

Kotter's 8-Step Change Model and the change management theory by Kruger address the process of managing change within organizations. However, they approach the topic from different perspectives and offer other frameworks for facilitating change. Kruger's change management theory focuses on identifying and overcoming barriers to change within organizations. It highlights the importance of understanding and addressing visible (cost, quality, and time) and invisible (perceptions, beliefs, and power dynamics) barriers to facilitate successful change initiatives. On the other hand, Kotter's 8-Step Change Model provides a more structured, step-by-step approach to implementing change. It emphasizes the importance of creating a sense of urgency, developing a clear vision and strategy, and securing buy-in from various stakeholders. The model also consolidates gains and embeds change within the organization's culture. While both models aim to help organizations navigate change, their emphasis and approach differ. Kruger's change management theory focuses on identifying and addressing barriers to change, while Kotter's 8-Step Change Model provides a more detailed, step-by-step process for implementing change. In practice, organizations may find value in combining elements of both models to create a more comprehensive change management strategy. From the perspective of changing the technical landscape of an organization, the change management theory by Kruger is focused on barriers that may better suit the adoption of new technologies such as blockchain.

Yet another theory that is similar to Kruger's theory is the ADKAR Model. ADKAR is an acronym representing the five sequential building blocks individuals experience during successful change (Hiatt & Creasey, 2018). The ADKAR model stands for Awareness, Desire, Knowledge, Ability, and Reinforcement. This model focuses on individual and organizational change, emphasizing the need to address each component for successful implementation. Bhattacharya and Kaur (2019) argue The ADKAR Model is a practical and goal-oriented change management framework that helps individuals and organizations to manage change effectively.

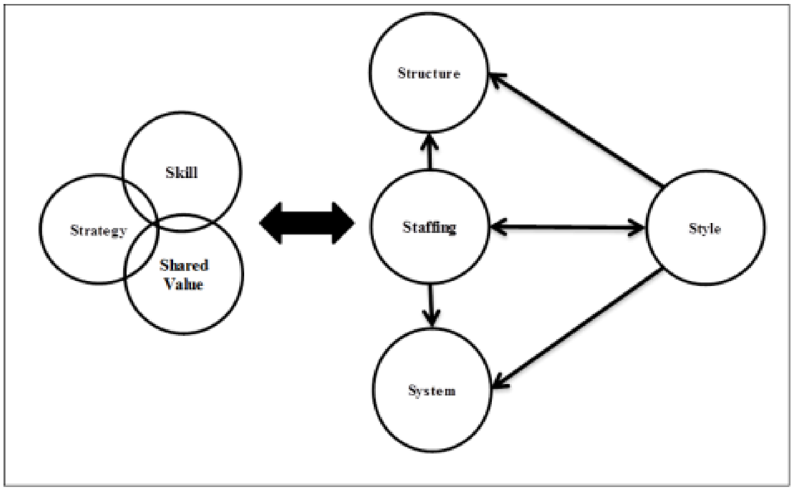
The ADKAR Model and Kruger's change management theory emphasize managing and facilitating organizational change but approach the subject differently. While both theories address the challenge of managing change in organizations, Kruger's change management theory concentrates on identifying and overcoming barriers to change, while the ADKAR Model emphasizes the individual's experience and progression through the change process. These theories can complement each other, as understanding and addressing individual and organizational barriers to change are crucial for successful implementation. Again these theories may be critical to changing the technology within an organization to ensure high resiliency and meet a user's needs more wholly.

Another theory that supports the change management theory is Bridges' Transition Model. Developed by William Bridges, this model focuses on people's psychological transitions during change; the model consists of three stages - Ending, Neutral Zone, and New Beginning - and aims to help organizations manage the human aspects of change (Hemmeter et al., 2015). According to Fernandez and Shaw (2017), organizational change will not be successful unless individuals transition through each stage, adjusting to the new environment and their roles within the organization. Mikkelsen and Plotnikof (2021) describe the Bridges' Transition Model as focusing on the psychological aspects of change, emphasizing the need to manage the emotions and reactions of people during a transition. While both models aim to facilitate change within organizations, Kruger's change management theory targets organizational barriers and structures, while Bridges' Transition Model emphasizes the individual experience and psychological aspects of change. The lean toward Kruger's theory is present within the technology space since barriers from the structural level may be more beneficial in comparison to an individual.

The last theory to discuss is McKinsey 7S Framework and how it supports the change management theory by Kruger. Tom Peters and Robert Waterman developed the McKinsey 7S Framework, and this model addresses seven critical aspects of an organization that need to be aligned for successful change: Strategy, Structure, Systems, Shared Values, Skills, Style, and Staff (Subiyanto, R., & Hatammimi, J., 2023). The framework highlights the interconnectedness of these elements and the need for a broad approach to change management. Razali et al. (2018) argue the model posits that an organization's success depends on the alignment and interdependence of these factors. By focusing on the seven elements, leaders can take a holistic view of their organization, understanding how changes in one area may affect others (Zhang, Y., & Liu, Y. (2017). Furthermore, Al-Swidi and Al-Hosam (2018) contend that this framework suggests that these seven elements must be aligned and mutually reinforcing for an organization to perform well. Figure 4 of McKinsey 7'S Model from Faturrohman et al. (2018).

Figure 4

McKinsey's 7s Model



Note. From "Application of RBV Theory and McKinsey 7'S Model on Start-up Company," by F. Faturrohman, T. Y. R. Syah, H. S. Darmansyah, & S. Pusaka, 2018, *Scientific Journal of PPI-UKM*, *5*(1), p. x.

Both models encourage a holistic view of organizational change, recognizing that addressing barriers or aligning elements in isolation may not be sufficient for achieving the desired outcome. The McKinsey 7S framework can be seen as complementary to Kruger's change management theory, as it provides a more detailed roadmap for assessing and aligning an organization's various components during change initiatives. Organizations can more effectively plan and execute change initiatives by considering both the barriers to change identified by Kruger's theory and the alignment of the seven elements in the McKinsey 7S Framework.

In order to better understand the change management theory by Kruger, it's essential to discuss supporting theories, such as Lewin's Change Management Model, Kotter’s 8-Step Change Model, the ADKAR Model, Bridges’ Transition Model, and the McKinsey 7S Framework. Lewin’s model emphasizes three main stages of change: Unfreeze, Change, and Refreeze, which prepares an organization for change, implements the change, and solidifies the organizational culture shift (Bărbulescu & Boitan, 2019; Serrat, 2017). Kotter’s 8-Step Change Model offers a structured approach to managing organizational change, focusing on urgency, vision, communication, and anchoring change within the corporate culture (Ali et al., 2020; Raineri, 2017).

The ADKAR Model, focusing on Awareness, Desire, Knowledge, Ability, and Reinforcement, highlights the importance of addressing each component for successful change implementation (Bhattacharya & Kaur, 2019; Hiatt & Creasey, 2018). Bridges’ Transition Model emphasizes people’s psychological transitions during change, consisting of an Ending, Neutral Zone, and New Beginning, aiming to manage the human aspects of change (Fernandez & Shaw, 2017; Mikkelsen & Plotnikof, 2021). Finally, the McKinsey 7S Framework targets seven critical elements of an organization that need an alignment for successful change: Strategy, Structure, Systems, Shared Values, Skills, Style, and Staff (Al-Swidi & Al-Hosam, 2018; Zhang, Y., & Liu, Y., 2017).

These theories complement each other in their focus on managing change in organizations, offering various frameworks for facilitating change, addressing barriers, and understanding the individual and organizational experiences of change. Organizations may find value in combining elements of these models to create a comprehensive change management strategy, particularly when adopting new technologies, such as blockchain.

Contrasting Theories

It is also essential that we discuss the theories that contrast with Kruger's change management theory. One contrasting theory is the Complexity Theory. Complexity theory challenges traditional linear and reductionist approaches to change management by emphasizing the inherent uncertainty, nonlinearity, and unpredictability of change processes in organizations (Albsoul et al., 2021). According to complexity theory, organizations are complex adaptive systems that continuously evolve and self-organize in response to internal and external stimuli (Estrada-Jimenez et al., 2021). Change management should therefore focus on fostering adaptability and resilience rather than seeking to control and predict change outcomes (Cilliers, 2019). Burnes and Cooke, B. (2019) define the complexity theory as offering an alternative view of change management by focusing on the self-organizing nature of organizations and the emergent properties arising from the interactions between organizational actors.

When contrasting the complexity theory, Kruger's change management theory focuses on overcoming barriers to change by addressing visible and invisible factors, such as cost, quality, time, perceptions, beliefs, and power dynamics. In contrast, complexity theory emphasizes the unpredictable and adaptive nature of change in organizations, suggesting that change management should prioritize adaptability and resilience over control and predictability.

Another contrasting theory is the Appreciative Inquiry Theory. Appreciative Inquiry (AI) offers an alternative approach to change management, focusing on identifying and building upon an organization's strengths rather than fixing problems or overcoming barriers (Whitney et al., 2019). AI encourages organizations to engage in collaborative, strengths-based conversations to co-create a shared vision of the future and develop strategies for achieving that vision. The AI process typically involves four phases: Discover, Dream, Design, and Destiny (Bushe & Marshak, 2018). Furthermore, Cooperrider and Godwin (2019) define Appreciative Inquiry as a strengths-based, positive approach to change that emphasizes the generative power of inquiry and dialogue to create new possibilities and sustainable growth within organizations.

Kruger’s change management theory aims to identify and address barriers to change in organizations, whereas Appreciative Inquiry takes a more positive approach by focusing on building upon existing strengths and fostering collaborative, future-oriented conversations. While Kruger’s theory emphasizes overcoming obstacles, AI highlights the potential for growth and improvement by tapping into the organization’s strengths and resources.

Another contrasting theory to Kruger’s change management theory is action research. Action research (AR) is a participatory, democratic process concerned with developing practical knowledge to pursue worthwhile human purposes, grounded in a participatory worldview. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people (Coghlan and Brannick, 2019). Coghlan and Shani (2020) state action research is an approach to creating organizational change and development, which involves a family of research methodologies that pursue action (or change) and research (or understanding) at the same time,’ emphasizing collaboration, participation, and reflection in the pursuit of practical solutions to pressing organizational issues. Figure 5 provides the core elements of action research from Coghlan et al. (2014):

Figure 5

Action research

Note. From *Doing Action research in your own Organization*, by D. Coghlan, & T. Brannick, 2019, SAGE Publications.

The methodology of the change management theory often relies on frameworks and models that provide structured approaches to manage and implement change. While the action research theory follows a cyclical process in which researchers and practitioners actively engage in identifying problems, designing and implementing interventions, observing the results, reflecting on the outcomes, and refining the approach as needed. Furthermore, change management theory is primarily concerned with addressing barriers to change within organizations; the action research theory focuses on problem-solving and learning through collaborative, iterative processes. Change management theory provides frameworks and models for managing change, whereas

Action research emphasizes an ongoing cycle of planning, action, observation, and reflection to generate practical solutions and insights.

Yet, our final contrasting theory is the dynamic capabilities theory. Dynamic capabilities theory suggests that organizations can achieve a competitive advantage by developing and deploying capabilities that enable them to sense, seize, and transform themselves in response to rapidly changing environments (Teece, Peteraf, & Leih, 2016). Wilden and Gudergan (2020) describe the dynamic capabilities theory as an organization's capacity to purposefully create, extend, or modify its resource base, enabling it to adapt and reshape its operations in response to changing market conditions and environmental turbulence.

Change management theory by Kruger emphasizes recognizing and overcoming these barriers is essential for successfully implementing change initiatives. On the other hand, the dynamic capabilities theory highlights an organization's ability to create, extend, or modify its resource base to adapt to changing market conditions and environmental turbulence. The focus is on the organization's capacity to develop and leverage its resources, skills, and capabilities to respond to external changes and maintain a competitive advantage. Both theories are essential for understanding and managing change in organizations, but they approach the topic from different perspectives and emphasize different aspects of the change process.

In summary, while Kruger's change management theory focuses on identifying and addressing barriers to change within organizations, contrasting theories like complexity theory, appreciative inquiry, action research, and dynamic capabilities theory offer alternative perspectives on managing change. These contrasting theories emphasize various aspects, such as the unpredictable nature of change, building upon organizational strengths, problem-solving through iterative processes, and adapting to external modifications to maintain a competitive advantage.

When considering the importance of building resilient applications with blockchain technology, these contrasting theories may provide valuable insights into managing change effectively. Blockchain technology can introduce new challenges and opportunities, requiring organizations to be adaptable, resilient, and agile in their approach to change. For instance, complexity theory highlights the need for adaptability and resilience in unpredictable changes, which can be essential when adopting blockchain technology. Likewise, dynamic capabilities theory underlines the importance of developing and leveraging organizational resources, skills, and capabilities to respond to external changes, such as the rapidly evolving blockchain landscape. Organizations seeking to implement blockchain technology should consider these contrasting theories in their change management strategies. By combining the insights from Kruger’s change management theory and these alternative perspectives, organizations can develop a more comprehensive understanding of change processes, ultimately facilitating the successful adoption of resilient blockchain applications.

Criticism of the Change Management Theory

There has been criticism of Kruger’s change management theory. For example, Alvesson and Sveningsson (2015) argue that the focus on visible and invisible barriers to change does not capture the full range of factors that affect change initiatives, such as the role of organizational culture and power dynamics. While these two factors are included underneath the iceberg, some believe they are not adequately represented in the change management theory. This may apply to all organizational changes, from the business side to the technology side.

Furthermore, Burnes (2015) criticizes the change management iceberg theory for its limited focus on individual-level resistance to change. The author emphasizes that the framework needs to consider group and organizational-level resistance to provide a more comprehensive understanding of the barriers to change. Considering these multiple levels of resistance is crucial for organizations to develop strategies that address the complex nature of change resistance. This can enable organizations to make more informed decisions and better anticipate the challenges that may arise during the change process.

Cameron and Green (2015) also argue that the change management iceberg theory does not provide a detailed roadmap for addressing the barriers to change. The authors suggest that a more comprehensive approach, such as Kotter’s 8-Step Process, may be more helpful in guiding organizations through change initiatives. They emphasize the need for a clear, actionable plan to overcome resistance and promote the successful implementation of change. By adopting a more structured approach, organizations can ensure they are better prepared to navigate the complexities of change and achieve their desired outcomes.

More criticism can be found from Hayes (2018), who discusses that the change management iceberg theory does not adequately address the role of emotions in organizational change. The author emphasizes that emotions, such as fear and anxiety, are critical drivers of resistance to change and must be considered in any change management framework. These emotions may directly impact an organization’s ability to adopt new technology, advance business processes, and improve customer satisfaction. It is essential for change management approaches to consider the emotional aspects of change, as this enables organizations to develop targeted strategies for addressing employees’ concerns and fostering a supportive environment.

Another example of criticism can be found in Worley and Mohrman (2014), who argue that the change management iceberg theory and other traditional change management approaches may be obsolete in today’s rapidly changing business environment. The authors suggest organizations adopt more agile and continuous change approaches to stay competitive. They emphasize the need for organizations to embrace a culture of adaptability and innovation, which allows them to respond more effectively to emerging challenges and opportunities. By doing so, organizations can be better positioned to capitalize on new market trends and maintain a competitive edge in an increasingly dynamic landscape. This shift towards more flexible and responsive change management approaches highlights the limitations of the Change Management Iceberg theory in addressing the complex and fast-paced nature of modern organizational change.

In summary, the criticism of Kruger’s change management theory mainly revolves around its inability to capture the full range of factors affecting change initiatives, its limited focus on individual-level resistance, the absence of a detailed roadmap for addressing barriers, the lack of emphasis on emotions, and its potential obsolescence in today’s rapidly changing business environment. These limitations can affect an organization's ability to adopt new technology, such as blockchain, and improve its processes and customer satisfaction. Building resilient applications with blockchain technology requires organizations to be agile and adaptable to change. However, the criticism of Kruger's change management theory suggests that it may not be sufficient for managing change in organizations implementing blockchain technology.

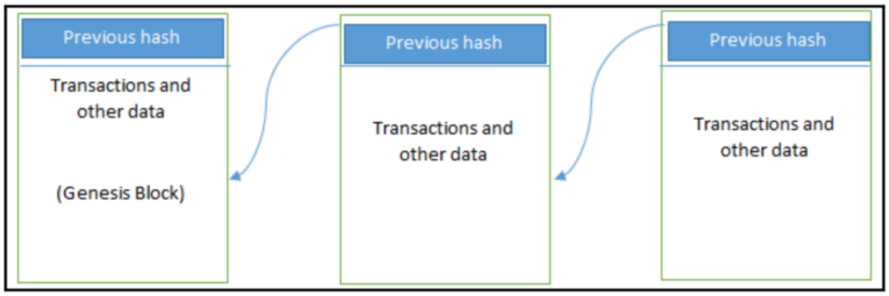
Organizations may consider adopting more comprehensive change management approaches, such as Kotter's 8-Step Process, to guide them through change initiatives. By doing so, organizations can respond more effectively to emerging challenges and opportunities, ensuring they stay competitive and implement blockchain technology in their processes. In conclusion, while Kruger's change management theory has its limitations, organizations can still benefit from understanding the barriers to change and adopting more comprehensive, agile, and emotionally aware change management approaches to build resilient applications with blockchain technology successfully.

Blockchain Overview

Blockchain technology is a decentralized, distributed ledger system that allows for secure, transparent, and tamper-proof record-keeping of transactions across a distributed network (Casino, Dasaklis, & Patsakis, 2019). Each transaction in a blockchain is grouped into blocks, which are then cryptographically linked to form a chain of blocks, as seen in Figure 6 by Bashir, I. (2017). This chain creates an immutable history of transactions that cannot be altered without the network's consensus (Nakamoto, 2008).

Figure 6

Blockchain



Note. From *Mastering Blockchain*, by I. Bashir, 2017, p. x.

Consensus is a process by which a group of participants in a decentralized network agree on data validity, such as transactions, within a distributed system like a blockchain. In blockchain technology, consensus mechanisms ensure that all nodes in the network maintain a consistent and accurate view of the shared ledger, thus fostering trust and security (Bano et al., 2017). Cryptographic hash functions ensure the integrity and security of the data stored in the blockchain, making it resistant to unauthorized modifications (Tschorsch & Scheuermann, 2016). Additionally, blockchain technology fosters trust among participants by ensuring transparency and providing a single source of truth for all recorded transactions (Lin, Shen, & Zhang, 2019).

In their 2021 study, Elo et al. (2021) shed light on this phenomenon within the Internet of Things (IoT) context. They argue for integrating Distributed Ledger Technology, a type of blockchain technology, in IoT systems, suggesting that this could significantly enhance system resiliency. They propose that the elimination of a central authority, enabled by blockchain's inherent consensus mechanisms, can serve to strengthen IoT federation resilience, a perspective that aligns with the observations of

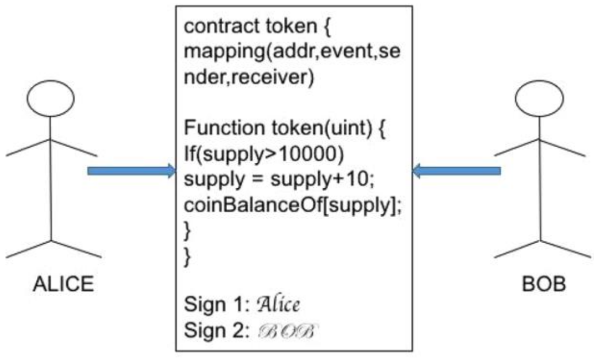
Bano et al. (2017). Their research further supports the growing trend of adopting blockchain technology across different sectors, indicating its transformative potential not just in finance, supply chain management, and health care, but also in bolstering IoT system integrity and reliability (Kshetri, 2018; Lin, Shen, & Zhang, 2019).

One of the main applications of blockchain technology is in cryptocurrencies, such as Bitcoin, which was the first and most well-known implementation of a blockchain-based digital currency (Nakamoto, 2008). Cryptocurrencies leverage the decentralized nature of blockchain to facilitate peer-to-peer transactions without the need for a central authority or intermediary, such as banks (Tapscott & Tapscott, 2016). This has led to the growth of decentralized financial services (DeFi) and applications (DApps), which aim to transform traditional financial services by offering more accessible, cost-effective, and secure alternatives (Zohar, 2020).

Smart contracts, self-executing agreements with the terms of the contract directly written into code, are another prominent application of blockchain technology. These contracts automatically enforce the terms and conditions specified in the code when predefined conditions are met, eliminating the need for intermediaries and reducing the risk of fraud and disputes (Christidis & Devetsikiotis, 2016). Figure 7 shows the interaction of smart contacts on the blockchain between two parties provided by Sinha and Chowdhury (2021). The Ethereum platform, which introduced the concept of smart contracts, has paved the way for numerous blockchain-based applications, including decentralized autonomous organizations and the tokenization of assets (Buterin, 2014).

Figure 7

Smart Contract Interaction



Note. From "Ethereum: A Next-Generation Smart Contract and Decentralized Application Platform," by V. Buterin, 2014, *Ethereum Project White Paper*, p. x.

Despite its potential benefits, blockchain technology faces several challenges and limitations, such as scalability, energy consumption, and regulatory issues. The scalability of blockchain networks, particularly those employing Proof of Work (PoW) consensus mechanisms, is limited due to the computational power required to maintain the network and validate transactions (Croman et al., 2016). Furthermore, the energy consumption associated with PoW-based systems, like Bitcoin, has raised environmental concerns and led to the development of alternative consensus mechanisms like Proof of Stake (PoS) (Mora et al., 2018). Regulatory issues also need to be addressed to ensure the responsible and lawful implementation of blockchain technology across industries (Yermack, 2017).

Proof of Work is a consensus algorithm utilized in various blockchain networks to maintain their security and validity, requiring participants to complete complex computational tasks before adding new blocks to the chain (Akbar et al., 2021). This process, known as mining, not only deters potential attackers by making it computationally expensive but also ensures that no single entity controls the entire network. As noted by Alzahrani & Bulusu (2020), the PoW consensus mechanism is designed to provide the network's security, as the difficulty of the cryptographic puzzle makes it infeasible for any single attacker to take control of the network. This approach, however, has been criticized for its high energy consumption and environmental impact. According to Mora et al. (2021), the Bitcoin network, which predominantly relies on the Proof of Work mechanism, was estimated to consume 121.36 terawatt-hours per year in 2021, comparable to the energy consumption of a mid-sized country like the Netherlands. As a result, alternative consensus mechanisms have been proposed to address these concerns.

Proof of Stake (PoS) is an alternative consensus mechanism employed in some blockchain networks to address the environmental and energy consumption concerns associated with Proof of Work systems. Instead of relying on computational power to secure the network, PoS utilizes the ownership of digital assets (i.e., cryptocurrency) as the primary factor in determining who validates new blocks. According to Kwon et al. (2020), in a PoS-based blockchain, validators are chosen based on the amount of cryptocurrency they hold and are willing to stake as collateral, creating a more energy-efficient system compared to PoW. This approach not only promotes a more environmentally sustainable model but also reduces the risk of centralization due to the distribution of assets. Nguyen et al. (2021) explain that PoS provides a more equitable distribution of rewards and lowers the barrier to entry for participation in the consensus process, thus reducing the risk of centralization. As such, Proof of Stake has gained traction as a viable alternative to Proof of Work in developing new blockchain networks.

Blockchain technology is a decentralized, distributed ledger system that enables secure, transparent, and tamper-proof record-keeping of transactions across a network of computers. Consensus mechanisms, like Proof of Work (PoW) and Proof of Stake (PoS), ensure the network's security and data integrity. While PoW requires participants to perform complex computational tasks, PoS chooses validators based on the amount of cryptocurrency they stake, making it more energy-efficient. Blockchain's key advantages include eliminating the need for a central authority, increasing trust and transparency, and fostering various applications like cryptocurrencies, decentralized financial services, and smart contracts. Despite its potential, blockchain faces challenges like scalability, energy consumption, and regulatory issues, leading to the development of alternative consensus mechanisms like PoS.

Current Blockchain Technology Uses

One prominent use case is in the field of finance, where blockchain has been employed to facilitate secure and transparent transactions through cryptocurrencies like Bitcoin and Ethereum (Nakamoto, 2008). Additionally, blockchain-based platforms such as Ripple and Stellar have been developed to enable faster, more efficient cross-border payment and remittance services, bypassing traditional intermediaries and reducing transaction costs (Hawlitschek, Notheisen, & Teubner, 2018). These platforms have the potential to reshape the global financial landscape, making transactions more accessible and cost-effective for individuals and businesses alike (Tapscott & Tapscott, 2017).

Fernandez-Vazquez et al. (2022) present an in-depth exploration of blockchain's application in sustainable supply chain management. Using the Analytical Hierarchical Process methodology, they examine blockchain's potential to enhance traceability, security, and efficiency within supply chain networks. They underscore blockchain's ability to provide an immutable, decentralized ledger that allows all parties to track goods' movements and ensure their provenance, aligning with the observations of Kamble, Gunasekaran, & Arha (2019). Moreover, they highlight the value of blockchain-enabled smart contracts in automating processes, thus reducing human errors and increasing overall efficiency. Their research supports the idea that this heightened visibility, coupled with the automation capabilities, can significantly boost trust and collaboration among supply chain partners, ultimately leading to more sustainable and resilient supply chains (Saberi, Kouhizadeh, Sarkis, & Shen, 2019).

In the health care sector, blockchain technology offers significant potential for improving data security, interoperability, and patient privacy. By creating a decentralized and tamper-proof ledger for storing patient records, blockchain can enable secure and transparent sharing of medical information among health care providers, improving coordination and facilitating better treatment outcomes (Kuo, Kim, & Ohno-Machado, 2019). Furthermore, blockchain can empower patients by granting them greater control over their data, allowing them to selectively share information with authorized entities and ensuring their privacy. This patient-centric approach to health information management has the potential to transform health care delivery by promoting patient engagement and personalized care (Metcalfe, 2020).

Lastly, blockchain technology has been applied to enhance the security and transparency of voting systems. By leveraging the immutable nature of blockchain, it is possible to create an auditable and tamper-proof record of votes, reducing the risk of electoral fraud and manipulation (Hardwick, Akram, & Markantonakis, 2019). Additionally, blockchain-based voting platforms can enable remote voting, making the process more accessible and convenient for citizens while maintaining the integrity of the electoral process. The adoption of such systems could lead to increased voter participation and trust in the democratic process, ultimately contributing to more inclusive and representative governance (O'Reilly & Janssen, 2020).

Blockchain technology has shown promise in various sectors, including finance, supply chain management, health care, and voting systems. In finance, it facilitates secure transactions through cryptocurrencies and enables efficient cross-border payments. In supply chain management, it enhances traceability and efficiency, helping to prevent fraud and improve collaboration. In health care, blockchain can improve data security and patient privacy, promoting better treatment outcomes and patient engagement. Finally, in voting systems, blockchain can increase security and transparency, potentially leading to greater voter participation and trust in the democratic process.

Traditional Resiliency Strategies

Current technology resiliency practices focus on ensuring the continuity of business operations and minimizing downtime in the face of disruptions, such as natural disasters, cyber-attacks, or system failures. These practices involve implementing robust strategies that encompass backup, recovery, and redundancy plans, as well as incorporating risk management methodologies (Alali & Gao, 2021). In the age of digital transformation, organizations across various industries are increasingly reliant on technology, thus making the need for resilient systems more critical than ever before (Suri & Pal, 2020). Ensuring the resilience of technology infrastructure helps maintain customer trust and satisfaction and safeguards an organization's valuable data and resources.

Database Resiliency

Traditional database resiliency practices have evolved to address the challenges associated with ensuring the availability, integrity, and accessibility of data in a continuously changing technological landscape. One such practice is the implementation of distributed databases, which involve partitioning data across multiple servers or locations. This approach increases fault tolerance by reducing the likelihood of a single point of failure and improving data recovery capabilities (Ceri & Pelagatti, 2021). Additionally, distributed databases can balance the workload among the servers, resulting in increased performance and responsiveness, especially when data access and processing demands are high.

Another practice in enhancing database resiliency is backup and recovery strategies. Regular and comprehensive data backups help organizations recover from data loss or corruption events, such as hardware failures or cyber-attacks (Tariq & Aslam, 2020). In addition to traditional full and incremental backup techniques, modern solutions offer continuous data protection mechanisms, which capture changes in real time, enabling recovery to any point in time. In simpler terms, continuous data protection systems constantly record every change that occurs in your data, similar to a live video recording, allowing you to restore data from any specific moment, unlike traditional backups, which only allow you to restore from the last backup time. Organizations can further improve recovery capabilities by storing backup data offsite or in the cloud, providing additional protection against disasters affecting the primary data center.

Finally, implementing database replication and clustering techniques contribute significantly to ensuring database resiliency. Replication involves the synchronization of data across multiple database instances, allowing for seamless failover in case of a system failure or disruption (Ceri & Pelagatti, 2021). Clustering, on the other hand, groups several servers together to act as a single unit, providing redundancy and load balancing. Both replication and clustering help maintain data consistency and high availability, which is essential for organizations with mission-critical applications and services that require uninterrupted access to their data.

Network Resiliency

Network resiliency practices aim to ensure the uninterrupted functioning of communication and data transfer across an organization’s infrastructure. One crucial practice in achieving network resiliency is the implementation of redundant network paths and components, which help mitigate the impact of a single point of failure (Bilal et al., 2020). Organizations can maintain network availability by incorporating redundant routers, switches, and connections in case of hardware failures, cable damages, or other disruptions. This redundancy can be achieved through diverse routing, where multiple paths are established between network nodes to provide alternate routes for data traffic during outages or periods of congestion.

Another practice in enhancing network resiliency is using network monitoring and management tools, which provide real-time visibility into the performance and health of the network infrastructure (Peng et al., 2021). These tools can help identify and address potential issues before they escalate into critical problems, enabling administrators to optimize network performance and resource allocation. Furthermore, advanced monitoring solutions can incorporate machine learning and artificial intelligence capabilities, allowing for the detection of unusual network patterns or behavior that may indicate security threats or vulnerabilities.

Finally, implementing robust network security measures is essential for ensuring network resiliency, as cyber-attacks can lead to significant disruptions and data breaches (Alrawais et al., 2020). Organizations can adopt a multi-layered security approach, which includes the deployment of firewalls, intrusion detection and prevention systems (IDPS), and secure access control mechanisms. Additionally, regular security assessments, vulnerability scanning, and penetration testing can help identify and address potential weaknesses in the network infrastructure, ultimately contributing to a more resilient network environment.

Cloud Computing

Cloud computing has revolutionized the way organizations manage and consume IT resources, offering a range of practices that enhance flexibility, scalability, and cost-efficiency. One such practice is the adoption of Infrastructure-as-a-Service (IaaS) models, which provide virtualized computing resources over the internet, eliminating the need for organizations to invest in physical hardware and maintenance (Hashem et al., 2020). IaaS enables businesses to provision computing resources on-demand, allowing them to scale infrastructure up or down according to their requirements, thereby optimizing costs and resource utilization. Adding to this narrative, Zou et al. (2022) explore the synergistic integration of blockchain technology with cloud computing systems, including IaaS models. Their systematic survey suggests that leveraging blockchain technology's decentralized, transparent, and secure attributes can add an extra layer of trust and reliability to cloud-based systems. For instance, this combined approach could ensure data integrity and privacy in IaaS models while facilitating secure, auditable transactions.

Another cloud computing practice is the utilization of Platform-as-a-Service (PaaS) offerings, which provide a complete development and deployment environment in the cloud, enabling developers to build, test, and deploy applications without the complexity of managing the underlying infrastructure (Khan and Al-Yasiri, 2020). PaaS solutions often include a suite of tools, libraries, and frameworks that streamline the development process and support multiple programming languages and architectures. This approach can significantly reduce the time-to-market for new applications and promote organizational innovation.

Finally, Software-as-a-Service (SaaS) is a popular cloud computing practice that delivers software applications over the internet, allowing users to access and interact with them through a web browser, without the need for local installation or maintenance (Liu & Mao, 2020). SaaS providers handle all aspects of software management, including updates, security, and scalability, offering organizations a subscription-based model that eliminates upfront costs and reduces the burden on IT teams. SaaS solutions have gained traction across various industries due to their ease of use, accessibility, and the potential for seamless integration with other cloud services.

Technology resiliency practices focus on ensuring business continuity, minimizing downtime, and protecting valuable data and resources in the face of disruptions (Alali & Gao, 2021; Suri & Pal, 2020). Key practices include distributed databases, backup and recovery strategies, and replication and clustering techniques for database resiliency (Ceri & Pelagatti, 2021; Tariq & Aslam, 2020); redundant network paths and components, network monitoring and management tools, and robust network security measures for network resiliency (Bilal et al., 2020; Peng et al., 2021; Alrawais et al., 2020); and IaaS, PaaS, and SaaS practices for cloud computing (Hashem et al., 2020; Khan and Al-Yasiri, 2020; Liu & Mao, 2020). Blockchain technology can address these resiliency practices by providing a decentralized, tamper-proof, and transparent infrastructure, which can enhance data integrity, security, and fault tolerance (Casino, Dasaklis, & Patsakis, 2019). Blockchain-based solutions can be integrated into various aspects of technology resiliency, such as database management, network security, and cloud services, ensuring a more resilient and secure environment (Mollah, Karim, & Rahman, 2021).

Blockchain Resiliency Strategies

One aspect of resiliency addressed by blockchain is data integrity, ensuring that information stored on the blockchain remains unchanged and verifiable (Casino, Dasaklis, & Patsakis, 2019). By creating a tamper-proof and distributed ledger, blockchain technology eliminates single points of failure and mitigates the risk of data manipulation, ultimately contributing to a more secure and reliable infrastructure. The table by Chowdhury (2018) compares centralized databases to blockchain databases:

Table 1

Blockchain Versus Centralized Databases

Issue	Block chain	Central database	Advantage
Trust building	Can operate without any trusted party	Need a central trusted party	Blockchain
Confidentiality of data	(by default) All nodes have visibility of the data	Restricts access to authorized person	Database
Robustness/fault tolerance	Data are distributed among nodes	Data are stored in central database	Blockchain
Performance	Takes time to reach concensus (e.g., 10min for Bitcoin)	Immediate execution/update	Database
Redundancy	(by default) each participating node has latest copy	Only the central party has copy	Blockchain
Security	(by default) use cryptographic measures	Uses traditional access control	Blockchain

Note. From "Blockchain versus database: a critical analysis," by M. J. M. Chowdhury, A. Colman, M. A. Kabir, J. Han, & P. & Sarda, 2018, *IEEE international conference on big data science and engineering*. (https://doi.org/10.1109/TrustCom/BigDataSE.2018.00186).

Another way blockchain technology enhances resiliency is through the use of smart contracts, which are self-executing contracts with the terms of agreement directly written into the code (Christidis & Devetsikiotis, 2016). Smart contracts can automate various processes, such as payments and inventory management, reducing delays and human errors while increasing overall efficiency. The automation capabilities provided by smart contracts not only streamline operations but also contribute to the resiliency of systems by minimizing the potential impact of human intervention or errors on critical processes (Saberi, Kouhizadeh, Sarkis, & Shen, 2019).

Furthermore, blockchain technology enables greater transparency and traceability, which are essential components of resiliency in sectors like supply chain management and finance. By providing an immutable and decentralized ledger, blockchain allows all parties involved to track the movement of goods or transactions in real-time, facilitating trust and collaboration among stakeholders (Kamble, Gunasekaran, & Arha, 2019). This enhanced visibility and traceability can lead to improved detection and response to potential disruptions, ultimately resulting in more sustainable and resilient systems.

Finally, blockchain technology can improve resiliency by enhancing security and privacy. The cryptographic mechanisms employed in blockchain networks ensure secure and verifiable transactions, while also providing privacy through techniques such as zero-knowledge proofs and ring signatures (Zohar, 2020). This combination of security and privacy features not only protects sensitive data from unauthorized access but also ensures that the system remains resilient against cyber-attacks and other potential threats. Overall, blockchain technology presents a viable solution for addressing resiliency challenges in various domains, providing a foundation for more secure, transparent, and reliable systems.

Blockchain technology addresses resiliency in several ways, including enhancing data integrity, streamlining processes through smart contracts, promoting transparency and traceability, and improving security and privacy. By creating a tamper-proof and distributed ledger, blockchain ensures information remains unchanged and verifiable, contributing to a more secure and reliable infrastructure (Casino, Dasaklis, & Patsakis, 2019). Smart contracts automate processes, reducing delays and human errors while increasing efficiency and system resiliency (Saberi, Kouhizadeh, Sarkis, & Shen, 2019). Additionally, blockchain's immutable and decentralized ledger enables transparency and traceability in sectors like supply chain management and finance, promoting trust, collaboration, and more resilient systems (Kamble, Gunasekaran, & Arha, 2019). Lastly, blockchain technology improves resiliency by enhancing security and privacy through cryptographic mechanisms and techniques such as zero-knowledge proofs and ring signatures, protecting sensitive data and ensuring system resilience against potential threats (Zohar, 2020).

Transition and Summary

This research explores Kruger's change management theory and how it relates to blockchain resiliency. This theory highlights the crucial understanding of both observable and hidden factors in project management. Observable factors, such as time, cost, and quality, are transparently managed in projects, while hidden elements—underlying cultural, power, and political dynamics—are frequently disregarded due to their intangibility but are essential for project success. The theory broadens the concept of time management beyond initial planning to include vital behavioral skills and considers both direct and indirect costs under cost management. The use of delimitations in the study ensured focus and alignment with research objectives, as they were described as consciously set boundaries by the researcher, including restrictions on the number and location of cases and specific qualifications for IT professionals, all within the context of exploring strategies for resilient systems among IT professionals with blockchain experience.

Another cornerstone of this section is the exploration of resiliency, specifically through blockchain technology. Blockchain bolsters resiliency via data integrity, process automation using smart contracts, and enhanced transparency, traceability, security, and privacy. By forming a tamper-proof, distributed ledger, blockchain assures that information stays consistent and verifiable, creating a secure, reliable framework. Smart contracts streamline various processes, diminishing delays and errors, hence fortifying overall efficiency and system resiliency. Following this exploration of blockchain and traditional resiliency strategies, subsequent sections will discuss data collection and analysis to answer the research question.

Section 2: The Project

In the section below, I will further explore the purpose of this research and my role as the researcher. This will be from the perspective of an IT professional with experience supporting enterprise applications and blockchain experience. Furthermore, I will discuss this study's research method and design to ensure the proper alignment with the research question and the problem being addressed. A deep dive into the data collection methods will be undertaken, with specifics outlined regarding instrumentation, collection techniques, and organizational strategies. I also aim to highlight potential challenges and their respective solutions throughout the data collection and analysis process. I will end this section by discussing this study's reliability and validity.

Purpose Statement

The purpose of this qualitative multiple-case study is to examine the strategies IT professionals use to support blockchain technologies to enable resilient systems. The study's target population comprises IT professionals hailing from development and infrastructure teams across the United States. Insights derived from this study could assist organizations by illustrating resiliency deficiencies within their IT systems and showcasing the capacity of blockchain technology to alleviate such risks. This could further suggest business leaders need to construct a resilient IT architecture that tackles potential shortcomings in IT infrastructure and procedures. By doing so, there may be a societal impact by potentially reducing downtime of essential IT platforms, including hospital systems, vital supply chains, and utility services.

Role of the Researcher

I have been employed in the technology industry since 2005, beginning as a desktop technician for an enterprise organization and then transitioning to server technical support. Currently, I am a technologist in an operations team that supports web-facing applications. Over the last 5 years, my focus has shifted from creating and maintaining applications in the operational space to enabling resiliency and optimal application performance. This focus spurred my interest in considering blockchain as a data layer for enterprise applications. Originally, my interest in blockchain technology was purely financial; however, my perception shifted as I noticed operational gaps within existing technologies. I aimed to explore these possibilities through my work and contribute to the ongoing dialogue on leveraging blockchain for operational efficiency and resilience.

As the researcher in this study, my role in the data collection process is central and multifaceted. I was responsible for designing and implementing the research methodology, selecting suitable participants, conducting interviews, collecting relevant documents, and overseeing the data collection process. Furthermore, my extensive experience in the technology industry has afforded me a valuable understanding of the context and nuances of the work of the IT professionals participating in this study, which enabled me to ask insightful questions and interpret responses with depth and accuracy. Although I did not work directly with the study participants, I ensured they had the relevant experience to explore the topic.

It was also crucial to recognize the potential for my personal experiences and perspectives to influence the research process. A researcher's personal involvement at various stages of qualitative research presents an ethical bias, which can influence study results(Bispo, 2022; Mackieson et al., 2019; Sanjari et al., 2014). To mitigate bias, I strived to maintain reflexivity throughout the data collection process, continually reflecting on my assumptions, biases, and influences and taking steps to ensure they did not unduly shape the research outcomes (Berger, 2015). This included strategies such as maintaining a research journal to document reflections and decisions made during the research process and seeking peer debriefing to gain external perspectives on the data and findings. Moreover, recognizing the inherent power dynamic between researcher and participant, I aimed to foster a respectful and collaborative relationship with participants, valuing their experiences and perspectives and striving to give voice to their experiences fairly, accurately, and respectfully.

My research employed video conferencing software for data collection, with both audio and video, which can reduce bias and enhance reliability (Johnson et al., 2020). I also planned to employ the member checking method to avoid misinterpretations of participants' responses (see Motulsky, 2021). This method, used in qualitative research, increased the credibility and validity of the collected data. I also planned to utilize triangulation methods in my study (see Farquhar, 2020).

To uphold ethical research standards, I used the *Belmont Report* as a framework, embodying its three fundamental ethical principles as described by Siddiqui and Sharp (2021): respect for persons, beneficence, and justice.

1. Respect for persons: This principle implies that individuals should be treated

as autonomous agents capable of making decisions for themselves. Additionally, individuals with diminished autonomy (for example, children, prisoners, or mentally impaired persons) should be afforded additional protections.

2. Beneficence: Researchers should aim to maximize benefits and minimize harm to participants. This means they must strive to design and conduct research in a way that ensures potential benefits significantly outweigh potential risks.
3. Justice: This involves ensuring a fair distribution of the benefits and burdens of research. For example, one group should not bear the brunt of research risks while another group reaps all the benefits.

These principles were implemented to ensure that participants could freely provide information and understand they could exit the study anytime.

First, I demonstrated respect for persons by treating all participants as autonomous individuals who can make informed decisions about their participation. I communicated all the necessary information about the study to the participants in a clear and understandable manner. This includes the study’s purpose, methodology, potential benefits, possible risks, and their right to withdraw from the study at any time without any negative repercussions.

Second, beneficence was carefully considered in my research design and execution. I ensured that the benefits of the research, such as gaining insights into IT strategies and the potential improvements to enterprise application resilience, significantly outweighed any potential risks, like time taken away from their usual duties or discomfort in sharing professional experiences. Additionally, I strived to minimize any potential harm by maintaining strict confidentiality and anonymity measures, ensuring that all participant information and responses were securely stored and used solely for the purpose of this study.

Lastly, the principle of justice was upheld by ensuring a fair distribution of the benefits and burdens of research. I carefully selected participants from different roles, levels, and team compositions, ensuring that no one group was overburdened with the demands of participation or excluded from the potential benefits. The insights gained from this study were intended to contribute to the professional development and knowledge of all participants and their teams, not just a specific subset. By diligently implementing these ethical research standards, I aimed to conduct a study that respected, protected, and benefited all participants in a fair and equitable manner.

Participants

The participants in this study were IT professionals from either infrastructure or development teams, each with a minimum of 8 years of experience supporting enterprise systems. This study employed a multiple-case approach, ensuring the participants came from diverse organizations with varied sector experiences. The sectors included in this study encompassed financial technology, health care, and local government. Although these participants had a basic understanding of blockchain technology, they had not directly used it in their current roles. The goal was to gather individuals with operational and developmental experience in enterprise applications to understand the resiliency gaps in these platforms. By focusing on these gaps, insights were gleaned about areas for improvement and the potential benefits of implementing blockchain technology. Additionally, a diverse pool of participants contributed to a comprehensive understanding of the issue.

To find participants, I utilized LinkedIn and attended relevant conferences. Many researchers have successfully leveraged social media to locate participants. With over 450 million users worldwide, LinkedIn has become a hub for exchanging knowledge, ideas, and opportunities (Matei et al., 2017). As a professional networking platform, LinkedIn provides invaluable resources for researchers seeking interview participants. Using the site’s advanced search features and vast user base, researchers could identify and connect with potential participants with the specific expertise or professional background relevant to their study.

I initially established a working relationship with potential participants through direct communication on LinkedIn. I compiled a shortlist of interested participants, ensuring they had the requisite experience to address the research question. However, considerable time was dedicated to recruitment. The enlistment of research participants was impeded by their time constraints, often due to heavy workloads, leading them to prioritize work over interview participation (Daly et al., 2019). I employed the elaboration likelihood model to mitigate this risk to facilitate persuasion. The ELM suggested that the topic’s relevance, the person’s ability to understand the message, and their motivation to process the message would determine the route they’d take to process the information (Scannell, 2021). I implemented strategies that respected autonomy and relied on persuasion and offers, being careful to avoid manipulation and coercion.

Research Method and Design

I established professional connections by contacting numerous potential participants via email, direct messages on LinkedIn, or video calls. After identifying those who expressed interest, I organized and classified them based on the criteria I had established for my participants. I recognized that there might be obstacles in forming these relationships (Wozney et al., 2019). Additionally, recruitment research, communication media, and information quality were crucial in attracting potential participants (Muduli & Trivedi, 2020). Focusing on communication media was one of the key mitigation strategies I used to find my participants.

Method

The research method that I adopted was qualitative. A qualitative study's philosophical point of view is often aligned with interpretivism or constructivism (Van der Walt, 2020). These perspectives emphasize the subjective nature of human experiences and the importance of understanding social phenomena within their specific contexts. Qualitative research is used to explore and understand the meaning and interpretation of individuals' experiences, beliefs, and behaviors. It acknowledges that reality is socially constructed and that multiple variations could exist. As a researcher conducting a qualitative study, researchers engage in in-depth interviews, observations, and textual or visual data analysis to gain insights into participants' lived experiences and the social processes at play (Liu, 2022). Qualitative methods offer a unique advantage in capturing the richness and complexity of human experiences, perceptions, and social phenomena (Hong & Cross Francis, 2020). Through in-depth interviews, observations, and textual or visual data analysis, qualitative research allows researchers to delve deeply into individuals' lived experiences, uncovering the nuances, meanings, and contextual factors that shape their perspectives (Rapport & Hughes, 2020). This depth of understanding is often challenging to achieve through quantitative or mixed methods, which typically focus on measurable variables and statistical analysis. Qualitative research allows for a more holistic and comprehensive exploration of the subject matter, providing a deeper understanding of the social and cultural dynamics.

In addition, qualitative research is precious when exploring new or relatively uncharted areas of study. When little is known about a phenomenon or when existing theories or frameworks are insufficient, qualitative methods can generate new insights and ideas (Kyngäs, 2020). Through open-ended interviews or observations, researchers can uncover unexpected patterns, find hidden factors, or challenge existing assumptions. Qualitative research allows for exploring diverse perspectives and provides a foundation for developing theories or hypotheses that can be further investigated using quantitative or mixed methods. Since I observed the experience of IT professionals, a qualitative best fits my research question.

Furthermore, qualitative methods excel in understanding the context-specific nature of social phenomena and the dynamic processes that occur within them (Izogo & Jayawardhena, 2018). By immersing themselves in the research setting and engaging with participants, researchers can understand the social, cultural, and environmental factors that influence individuals and their behaviors. Qualitative research can capture the temporal and situational aspects of phenomena, allowing for an examination of how events unfold over time and the interplay between different actors or variables (Spector & Meier, 2014). This nuanced understanding of context and process is often essential for informing interventions, policy development, or theory-building efforts. The nuanced reactions to the interview questions can derive information to address the IT problem.

While mixed methods and quantitative research have strengths and applications, qualitative methods offer distinct advantages when exploring complex human experiences, uncovering new insights, and understanding the contextual dynamics of social phenomena. Researchers may choose qualitative methods when seeking a deep understanding of subjective experiences, when investigating new or unexplored areas, or when aiming to unravel the intricacies of social processes (Njie & Asimiran, 2014).

Research Design

I chose to employ a multiple case study approach as the suitable qualitative method for my study. The primary aim of my research was to understand the specific strategies experienced blockchain IT professionals employ in supporting enterprise applications and how blockchain technology can increase resiliency. By examining multiple cases, I aimed to gain a comprehensive understanding of the diverse strategies used in different contexts and explore the potential benefits of blockchain technology in enhancing the resilience of enterprise applications. Given the nature of my objective, a case study approach is deemed appropriate for investigating these strategies in-depth.

To ensure data saturation in this research, I implemented several strategies. First, I selected four cases regarding organization size, industry sector, and geographic location.

This maximized the variability of strategies employed by IT professionals and the contexts in which blockchain technology was utilized, enhancing the richness and depth of the data collected. Second, within each case, I interviewed multiple IT professionals with different experience levels and roles within their organization. This allowed for various perspectives on the strategies employed and the use of blockchain technology in supporting enterprise applications. Third, the interviews were conducted until no new themes or insights emerged from the data, which is a standard marker of data saturation. To ensure this, I continuously analyzed the interview data while data collection was ongoing, allowing me to identify when saturation had been reached. Lastly, additional data sources, such as organizational documents and IT professionals' reflections, further contributed to achieving data saturation. By employing these strategies, I aimed to collect comprehensive and detailed data that thoroughly explored the topic at hand and ensured the credibility and trustworthiness of the research findings.

Several factors drove the choice of a multiple case study design. Firstly, it allows for an in-depth exploration of the specific strategies employed by experienced IT professionals in supporting enterprise applications. By examining multiple cases, the researcher can identify commonalities, differences, and patterns across various contexts, providing a comprehensive understanding of the topic (Bass et al., 2018). Additionally, a multiple case study design offers the opportunity to triangulate findings and enhance the credibility and validity of the research (Bass et al., 2018). By studying multiple cases, the researcher can strengthen the reliability of the results, as patterns or themes that emerge across different cases are less likely to be due to chance or specific contextual factors

(Hartley, 2004).

Other research methods, such as surveys or experiments, were not selected for several reasons. Surveys might provide a broad overview, but they may not capture the depth and nuances of the specific strategies employed by IT professionals in supporting enterprise applications. Conversely, experiments typically focus on controlled variables and may not adequately capture the complexities of real-life contexts (Shamay-Tsoory & Mendelsohn, 2019). Given the research objective of understanding specific strategies and exploring the role of blockchain technology, a qualitative approach was deemed more appropriate for capturing the richness and contextual factors at play.

Lastly, the multiple case study design aligns well with the problem being studied. It allows for an exploration of the strategies employed by IT professionals in real-life settings, providing a deeper understanding of the complexities and challenges they face (Paparini et al., 2020). The design also facilitates examining how blockchain technology can increase resiliency in these applications, as multiple cases can reveal different ways blockchain is implemented and its impact on resilience. Moreover, the design allows for a comprehensive analysis of the interplay between strategies, contexts, and the role of blockchain, contributing to the development of practical insights and recommendations for IT professionals and organizations in enhancing the resilience of enterprise applications.

Overall, the multiple case study design was chosen due to its ability to provide in-depth insights, triangulate findings, capture contextual nuances, and explore the specific strategies employed by IT professionals in supporting enterprise applications and the role of blockchain technology in increasing resiliency. In addition, the multiple case study design allows for a holistic examination of the problem, considering various perspectives and contexts. It offers a comprehensive and nuanced understanding of the strategies employed by IT professionals, taking into account the unique challenges and opportunities that arise in different organizational settings and industry sectors. Furthermore, this design enables the researcher to identify common patterns, variations, and potential factors that contribute to the success or limitations of the strategies, providing valuable insights for practical applications and informing future research in the field.

Population and Sampling

I used two cases with two participants in each company for a total of four interviews since my research will be a multi-case study. These two cases provided me with the information to address the research question concerning IT problems. Boddy (2016) argues that qualitative research often concerns developing a depth of understanding rather than a breadth. This led me to believe four interviews were enough to explore this topic. My participants were all IT professionals from the infrastructure or development teams with blockchain experience supporting enterprise applications. Farrugia (2019) posits that in purposeful sampling, the researcher strategically chooses participants based on predetermined criteria, ensuring that the data gathered is optimally suited for addressing the research question. The participants for the case studies will be selected using purposeful sampling. This means that the researcher will strategically choose participants based on predetermined criteria, such as industry experience and role relevancy. The objective is to include participants who can offer valuable insights into the IT problem being studied.

Following Farrugia's assertion, I carefully selected these participants based on their industry experience and role relevancy, with the primary objective being their potential to offer valuable insights into the specific IT problems under consideration. By focusing on a small but contextually rich set of cases, I was able to delve deep into each case's unique circumstances and experiences, thus comprehensively exploring the issue. As Boddy (2016) advocated, this depth-focused approach will enable me to thoroughly understand the problem area, revealing nuances and complexities that may have been overlooked in a broader, less focused study.

In addition to these measures, I implemented an iterative data collection process to ensure data saturation within my population, in line with the recommendations of Saunders et al. (2018). This approach involved continually reviewing and analyzing data throughout the research process, which enabled me to monitor the emergence of new themes or insights and to determine when data saturation were achieved, defined as the point where no new information is forthcoming from new sampled units. Moreover, I utilized triangulation of data sources, as Carter et al. (2014) suggested, collecting and cross-verifying information from different sources, including direct interviews, company documents, and participant observations. This approach increased the robustness of my findings. It helped confirm when data saturation had been reached, enabling me to ensure that new data collected were consistent with the previously obtained data.

Additionally, I maintained an open dialogue with my participants throughout the research process, as proposed by Morse (2015). This involved revisiting participants for follow-up interviews or clarifications when necessary, which ensured I had thoroughly explored each topic and reinforced the depth and richness of the data collected. Finally, I also employed member checking, a process whereby participants were allowed to review and confirm the accuracy of the interpretations made from their data (Birt et al., 2016). This procedure further ensured the depth and validity of the data collected and contributed to confirming data saturation. Through these comprehensive and rigorous measures, I ensured that data saturation was achieved within my population, thereby strengthening the credibility and reliability of my findings.

Ethical Research

Ethics play a crucial role in research, as ignoring ethical considerations can lead to various types of harm to participants. It is essential to obtain informed consent from participants, ensuring they know the study's purpose, benefits, and potential risks before agreeing to participate. The conditions for acceptable informed consent are full disclosure, capacity, and voluntariness (Xu et al., 2020). Full disclosure involves providing all the required information for participants to make an independent decision, while capacity refers to their ability to understand the information and make a reasonable judgment. Voluntariness ensures that participants can freely decide without any undue influence or pressure (Hyatt & Lobmaier, 2020).

In my study, participants were provided full disclosure and voluntarily chose to participate. To ensure full disclosure, participants were thoroughly informed about the purpose, methods, potential benefits, and possible risks associated with their involvement in the study before they decided to participate. They were also informed that they could withdraw their participation at any time without facing any consequences, thereby promoting transparency and ethical integrity in the research process. I adhered to ethical principles such as respect for persons, benevolence, and justice, as outlined in the Belmont Report. Participants were informed of their freedom to withdraw from the study at any point if they felt uncomfortable, with the contact information provided to communicate their decision. The right to withdraw was communicated at the beginning of the interview. The right to withdraw is universally recognized to protect participants from potential harm during the research (Favaretto et al., 2020).

Participants were encouraged to join voluntarily, knowing that their insights could improve the protection of blockchain applications and add to the IT body of knowledge. The consent form clarified that participants were only required to share their knowledge of the research topic and that their involvement carried no risks. To ensure confidentiality, participant identities were anonymized using codes, with a password-protected Excel spreadsheet and encryption for storage. All collected data were encrypted and stored securely, following data protection guidelines, and were set to be destroyed after five years.

Data Collection

Instruments

My study's data collection tool were the semi-structured interview protocol, a qualitative instrument designed to gain insights into IT professionals' experiences, views, and practices in implementing blockchain technologies (Biasutti et al., 2022). The protocol included open-ended questions tailored to explore the strategies these professionals used and the challenges they faced. In a qualitative research interview, the researcher aims to understand what the participants said to gather their experiences, perceptions, thoughts, and feelings (Moser & Korstjens, 2018). This tool did not produce numerical scores; its value lay in the rich, descriptive data it yielded. The validity of this instrument was assessed through pilot testing, ensuring that the questions were clear, understandable, and relevant to the research questions. Raw data were available upon request from the researcher.

Each variable in this study comprised qualitative data derived from the interview responses. These included, but were not limited to, strategies adopted for blockchain integration, challenges encountered, perceived impact on system resilience, and recommended improvements in current practices. These variables provided a rich understanding of the study's focal points. For instance, 'strategies adopted for blockchain integration' referred to specific actions or approaches used by IT professionals in incorporating blockchain technologies into existing systems to increase resiliency.

In qualitative research like this one, traditional psychometric properties associated with quantitative scales, such as validity and reliability, translate into the trustworthiness and rigor of the data collection and analysis process. My study employed several strategies to ensure this trustworthiness. The trustworthiness of the research was one of those shared realities, albeit subjective, wherein readers and writers found commonality in their constructive processes (Stahl & King, 2020). For instance, to address the validity threats, I adopted member checking, where participants were invited to review and confirm the accuracy of the interview transcripts and preliminary findings. This helped ensure that the research accurately reflected their perspectives and experiences. In this context, I also employed consistent coding and interpretation paralleled test-retest reliability, which is more relevant to quantitative studies. The study used a systematic and transparent coding process to maintain internal consistency. Revisions to the interview protocol occurred based on the pilot testing feedback or during the iterative data collection and analysis process, where new insights necessitated modifications to the interview guide to better capture the research focus, which was performed in early courses in the curriculum.

Data Collection Technique

My research question was: What strategies do IT professionals use to support blockchain technologies to enable resilient systems? To seek an answer, I concentrated on IT professionals who have supported enterprises for at least eight years in small to medium organizations with blockchain experience. The goal was to comprehend these professionals' strategies to support enterprise applications. This was achieved through conducting interviews and analyzing organizational documents related to IT support.

A semi-structured interview strategy was employed to facilitate the interviews, a method known for its inherent flexibility and reciprocity between the interviewer and interviewee. Eppich et al. argues (2019) that a well-crafted semi-structured interview guide would include predetermined questions while allowing flexibility to explore emergent topics based on the research question. This format allowed for spontaneous follow-up questions based on the responses received, contributing to the depth and richness of the data collected. Additionally, video interviews provided the interviewer with valuable social cues such as body language, voice tone, and other non-verbal information, which aided in a more nuanced understanding of the participant's perspectives.

The data collection strategy was divided into several phases. The initial phase involved establishing the suitability of semi-structured interviews for this research question, as these interviews are particularly effective in eliciting participants' experiences, thoughts, and feelings. The semi-structured interview is an exploratory interview used most often in the social sciences for qualitative research purposes (Magaldi & Berler, 2020). The subsequent phase involved updating my understanding of the subject matter through relevant literature and seminar papers and setting a conceptual groundwork for the interviews. This was followed by developing a semi-structured interview guide consisting of predetermined open-ended questions and follow-up queries. This interview guide was tested before implementation to ensure clarity and effectiveness.

The final phase encompassed the interviews themselves. Participants were given a thorough briefing and were required to provide their consent before commencing the interviews. Post-interview, additional meetings were scheduled with participants for member-checking, a process that facilitated the validation of qualitative results by allowing participants to confirm the accuracy of their responses. This iterative process was repeated until no new information emerged.

Data Organization Techniques

It was critical in qualitative research to manage data effectively, as this was key to the success of any study. Data needed to be analyzed to lend meaning to the research, and it also needed to be securely stored throughout the study period and appropriately disposed of afterward. As Saldana (2015) argued, qualitative data analysis searched for general statements about relationships and underlying themes. In line with this perspective, I encrypted the data from the study interviews using a robust data protection software product. These files were then stored on a cloud-based platform for additional protection against damage or theft. Physical data copies were securely stored in a locked safe throughout the study and were returned to the participants upon completion. Following the university's guidelines, all transcribed data will be disposed of after five years. Similarly, video and audio recordings were destroyed after transcription to ensure participant confidentiality.

All collected data forms, including recorded interviews, field notes, and organizational documents, were organized using a software solution. This software enabled efficient coding, labeling, categorization, and theme development within one consolidated platform. The software also provided a logbook feature, a research diary recording the study's progression. I used the MAXQDA 2022 software to organize this information. Woods, Paulus, Atkins, and Macklin (2016) highlighted that "Technological tools can assist in the organization and analysis of qualitative data, enhancing the rigor and depth of qualitative research." Coding in MAXQDA 12 was intuitive, and the program offered multiple options for open and focused coding procedures (Oswald, 2019).

The initial step involved uploading the interview audio files and related data into the software. I generated verbatim text from the audio using the software's transcription capabilities. Data exploration commenced as soon as it was collected and uploaded into the system. The software's memo function facilitated the addition of notes and comments throughout the process. As Silverman (2017) suggested, the software could facilitate data organization, enhance analytical reflexiveness, and assist in presenting findings. I used the software's coding and categorization function, which allowed themes to emerge as coding and categorization progressed gradually. All processes and steps throughout the study were meticulously documented using the software's built-in logbook.

Data Analysis Technique

This research aimed to understand IT professionals' strategies to support enterprise applications and how blockchain technology might boost resiliency. These meanings and understandings were inherently qualitative and procured through a semi-structured interview and other qualitative data sources, such as an organization's policy documents (Kallio et al., 2016). I utilized the MAXQDA software to consolidate all collected data into a single location, thus simplifying access for analysis.

The recorded interview audio was transcribed verbatim to ensure accuracy and completeness, capturing every spoken word. In addition to interviews, organizational documents such as policies were captured and stored. These documents were scanned and converted into an electronic format if they were paper-based and then examined for their potential to answer the research questions.

The use of method and data triangulation ensured the truthfulness of the analysis and rigor of the research. Triangulation enabled the use of multiple data sources to gain a comprehensive understanding of a phenomenon and to ensure the validity of the research. Triangulation ensured that the information derived from research data accurately reflected the truth (Moon, 2019). This study used a semi-structured interview and documents to collect data. This multiple case study involved interviews with different individuals in various cases, making the use of data triangulation appropriate.

The data set were analyzed using a five-step procedure. These steps included data logging, creating anecdotes, vignettes, data coding, and thematic analysis. Research showed that vignettes were useful in disseminating complex and applied information to practitioners, with research mainly utilizing written and audio vignettes to disseminate good practices (Szedlak, 2019). Data logging involves documenting the raw data collected from all sources and identifying all issues. Anecdotes of the collection were then created to help develop the themes. The next step was to develop vignettes of the investigation to provide a deeper understanding of the phenomenon. Following this, the collected data were coded by assigning tags to related themes from different sources. The MAXQDA qualitative software was used to facilitate this process.

Finally, thematic analysis was used to make sense of the collected data. The goal of thematic analysis was to identify patterns in a qualitative dataset and to explore an individual's understanding or interpretation of a concept. The major themes that emerged were defined using knowledge gained from literature. Themes were conceptualized from the categories of codes to create meanings that could be determined based on literature and interpreted beyond the types of data for more significant purposes by linking the raw data to research literature. Themes then constituted some form of codebook or template, which enabled a structured approach to data interpretation (Cassell & Bishop, 2019). The discussion of these major themes considered inputs from current studies related to the research topic.

Reliability and Validity

Ensuring research reliability and validity was paramount to creating a high-quality and practical knowledge base in any subject matter. The capacity of a qualitative study to effectuate emancipatory goals or facilitate social action could be gauged by its validity (McCabe & Holmes, 2009). Therefore, robust measures to guarantee the validity of research were not merely advisable but imperative. Conversely, if the quality of a qualitative study was compromised, it might result in unreliable data, leading to inaccurate conclusions and misunderstandings.

Unlike in quantitative research, where the validity and reliability depended on the instrument's design, a qualitative research study's quality largely relied on the researcher, who played a role similar to the instrument in the research process. Validity and reliability were inseparable concepts in this context, represented by terms like credibility, transferability, and trustworthiness (Kettunen & Tynjälä, 2018).

For instance, the concept of reliability, as utilized in quantitative studies, might not apply to qualitative research, which should preferably adopt consistency instead. On the other hand, the validity of qualitative studies should have been determined by the appropriateness of the tools, processes, and data involved. This implied that the research question, the chosen methodology, the design of the study, the sampling and data analysis methods, and finally, the drawn conclusions had to all be valid for the intended outcome, sample, and context.

Various strategies were employed to ensure credibility in this study, including those that considered most of the reliability and validity definitions, as discussed earlier. It was also observed that validation procedures needed to be integrated into the ongoing research process rather than implemented post-facto, allowing potential threats to validity to be addressed during the study.

Reliability

Reliability in qualitative research refers to the consistency, stability, and replicability of the researcher's observations and findings (Tuval-Mashiach, 2021). It's about ensuring that the data collection and analysis methods would yield similar results if the study were replicated under similar conditions. Unlike quantitative research, where reliability is often tied to metrics like test-retest reliability, inter-rater reliability, or internal consistency, qualitative research focuses on trustworthiness and authenticity, ensuring the researchers' interpretations are true to the participants' experiences and perspectives (Curtin & Fossey, (2007).

An essential aspect of achieving reliability in qualitative research is the use of rigorous methodological procedures. These include triangulation, peer debriefing, member checking, and keeping a thorough audit trail. Triangulation involves using multiple data sources, methods, investigators, or theories to cross-verify findings (Sridharan, 2021). Peer debriefing allows for an external check of the research process, and member checking entails returning to the participants for confirmation of the findings or interpretations. The audit trail includes detailed documentation of the steps taken in the data collection and analysis processes to ensure transparency and reproducibility.

Despite these strategies, critics often argue that the subjectivity inherent in qualitative research compromises its reliability (O'Connor & Joffe, 2020). However, qualitative research aims not to achieve statistical generalizability but to delve deeply into a phenomenon and understand the intricacies of human behavior and experience. The consistency or reliability of qualitative research should therefore be seen in terms of the coherence of the findings, the depth of insight generated, and the resonance of the results with the participants' experiences. As such, dependability and confirmability are often used in qualitative research, emphasizing the need for the research process and findings to be logical, traceable, and documented.

Validity

To enhance the validity of my qualitative study, I employed several strategies. One such strategy was member checking, where researchers presented their interpretations to the participants to verify the accuracy of their understanding. However, the use of member checking was infused with assumptions about reality and knowledge production that sat (conceptually) uncomfortably with reflexive TA—including the notion that there was a truth of participants' experiences that could be accessed if the potentially distorting effects of researcher influence were kept in check (Braun & Clarke, 2023). Triangulation, which involved collecting data from multiple sources, using various methods, or employing different theoretical perspectives, was another strategy I employed to enhance validity. Additionally, I engaged in reflexivity, a process of continually reflecting on and critically examining my biases, theoretical predispositions, preferences, and so forth, that might affect the research process and findings. Reflexivity allowed me to recognize, understand, and control my potential influences on the research, enhancing its validity (Berger, 2015).

However, there were complexities around validity in qualitative research. Some qualitative researchers argued that traditional notions of validity did not apply to qualitative research due to its inherently interpretive and context-dependent nature (Selvi, 2019). Instead, they used alternative terms like trustworthiness, credibility, transferability, and confirmability. The use of these alternative terms underscored the epistemological differences between quantitative and qualitative research, with the latter prioritizing deep, contextualized, and interpretive understanding of human experiences over generalizability, predictability, and control. Despite these differences, the central concern for both qualitative and quantitative research remained the same: producing accurate, credible, and insightful knowledge about the phenomena of interest.

Credibility

I used the triangulation technique to bolster credibility and minimize biases in my study. This involved incorporating multiple and diverse data sources to achieve convergence. Combining different methods, like case studies and document analysis, yielded richer data and heightened authenticity. Triangulation resulted in a comprehensive set of findings, enhancing the credibility of my research (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014). Furthermore, Fusch and Ness (2015) asserted there was a direct correlation between data saturation and triangulation, with data triangulation being a strategy to ensure data saturation.

Member checking served as an effective way to prevent misinterpretation of participants' insights. This process involved presenting participants with the data and my interpretation, allowing them to confirm or correct their intended meanings. This was a crucial check for validation in qualitative research, as it reflected the socially constructed reality and depicted what the participants perceived. The benefit of member checking was that it could reinforce the data and lend more credibility to my study.

Collecting a diverse and detailed data set facilitated a comprehensive understanding of participants. This data included what participants said, did, wrote, or produced. In my case, interviews, documents, and field notes were used (Namey, Guest, Thairu, & Johnson, 2018). Gathering sufficient data provided a complete depiction of the phenomenon. Furthermore, ensuring rich data granted detailed insight into the cases or phenomena under study (Bowen, 2020). To reduce research biases and improve my study, debriefing sessions with a trusted peer were held (Birt, Scott, Cavers, Campbell, & Walter, 2016). Moreover, sharing the study reports with the participants post-research to explain the results aided in reinforcing my understanding and interpretation. Such sessions were known to lessen biases and enhance the truth value (Malterud, Siersma, & Guassora, 2016).

Transferability

Thick descriptions are critical in rendering a study transferable. These detailed accounts assist readers in determining the truth-value of the research. Providing rich details about the context also improves the transferability of the study (Elo, Kääriäinen, Kanste, Pölkki, Utriainen, & Kyngäs, 2014). Transferability can be further enhanced by employing purposeful sampling methods and providing a detailed description of the process. It’s also recommended to transcribe the interview verbatim for future reference, and ensure the analysis process is documented comprehensively. To ensure transferability, these suggestions are meticulously adhered to in the study.

Confirmability/Dependability

A transparent and precise description of the research process, starting from the initial outline to the development of the method and, finally, reporting of findings, contributes to the confirmability of a study. It is also beneficial to maintain a research diary, documenting issues and challenges encountered during the process and how they were resolved (Etikan, Musa, & Alkassim, 2016). This approach strengthens the connection between the study’s aim, design, and methods. Moreover, discussing emerging themes with experts in an open process helps challenge assumptions and reach a consensus.

To enhance dependability and confirmability, tracking and documenting the research processes from beginning to end is crucial. This thorough documentation facilitates the production of detailed and transparent reports at the conclusion of the study (Nowell, Norris, White, & Moules, 2017). An excellent transparent report of the research steps taken throughout the project enhances the study’s credibility and dependability. Maintaining an audit trail is a key strategy for establishing the confirmability of qualitative findings. The confirmability of a study can be improved by incorporating an audit trail of the research to demonstrate that the study was conducted with substantial care, thus improving its trustworthiness.

Transition and Summary

This qualitative multi-case study investigates the strategies utilized by IT professionals to strengthen blockchain technologies, consequently improving system resiliency. The targeted demographic comprises IT professionals from infrastructure and development teams across the United States. The research may highlight deficiencies in the resiliency of IT systems within organizations and the potential of blockchain technology to mitigate such risks. By demonstrating this, the study may suggest that business leaders must devise a resilient IT architecture that addresses potential inadequacies in IT infrastructure and procedures. This, in turn, could have societal implications by potentially minimizing the downtime of crucial IT platforms, such as hospital systems, essential supply chains, and utility services. My technology industry experience and interest in applying blockchain as a data layer for micro-service applications informed the study's focus. In Section 3, I will delve into a detailed discussion of the results derived from the collected interview data. This analysis will aid in formulating conclusions from the data.

Section 3: Application to Professional Practice and Implications for Change

Introduction

This qualitative, multiple case study was conducted to investigate the strategies employed by IT security managers for the secure deployment of blockchain technology. Data for this study were gathered through semistructured interviews with four IT Professionals from companies specializing in blockchain and a review of company documents. Data analysis revealed three main themes: (a) decentralization, (b) privacy, and (c) transaction speed. This study helps to understand how IT professionals can support blockchain technologies to enable resilient systems. Additionally, it discusses the role of decentralized architectures in enhancing system resilience and reducing vulnerabilities associated with centralized models. Furthermore, the study sheds light on the practical implications and challenges faced by IT professionals in adapting and implementing blockchain technologies within established IT infrastructures. In this section, I delve into the findings, their relevance to professional practice, their social change implications, action recommendations, suggestions for subsequent research, and a conclusion.

Presentation of the Findings

The research question for this study was “What strategies do IT professionals use to support blockchain technologies to enable resilient systems?” My target population was IT professionals from the development and infrastructure teams with blockchain experience in the United States. I used a purposeful sampling strategy to select and interview four IT professionals within two companies specializing in blockchain technology in the smart contract industry, all of whom possess extensive experience in blockchain systems. Data were collected through semistructured interviews and a comprehensive review of company documents to achieve triangulation. Member checking was performed with the participants to validate the interpretations of their input. Data saturation were confirmed when data collection reached a point where no new themes emerged. The collected data were analyzed using a five-step procedure comprising data logging, anecdotes, vignettes, data coding, and a thematic network (Akinyode, 2018).

All participants were voluntary and consented to join the study by stating “yes” in the audio recording. Pseudonyms were used to protect the identities of the participants’ names (P1-P4), and their company names (C1-C2) are confidential. Each company provided two participants. P1 and P2 are in C1, and P3 and P4 are in C2. Each participant was interviewed for about 45 minutes using Microsoft Teams. The video interviews were transcribed using Microsoft Teams and Supernormal notetaker. All documentation and transcription were uploaded into the MAXQDA document system to analyze and develop themes on the given data. The results align with the literature review’s change management theory and analysis.

Theme 1: Decentralization

Decentralization is a cornerstone for building resilient systems by eliminating single points of failure, characteristic of centralized models, which are vulnerable to attacks and system downtimes (Aoun et al., 2021). In a decentralized system, data and control are distributed across a network of nodes, ensuring that the compromise or failure of one node does not jeopardize the entire system. Through a decentralized protocol, the owners have absolute authority over their resources and have the right to exchange assets with anyone at any time (Hazari & Mahmoud, 2020). IT professionals leverage this principle, implementing strategies that distribute data and control to mitigate the risks associated with centralized models and foster environments that are less susceptible to attacks. This architecture also fosters enhanced security and robustness, requiring consensus among multiple nodes to validate transactions or make changes, making it inherently resistant to fraudulent activities and cyber-attacks. Furthermore, IT professionals ensure that decentralized systems maintain adaptability and can recover swiftly from adverse situations, which is paramount for maintaining system functionality and resilience. By reducing reliance on a central authority and fostering a more democratic and robust infrastructure, decentralization is pivotal in cultivating system resilience.

The participants discussed the concept of decentralization and how it can benefit the resilience of enterprise systems. For example, P1 discussed the uses of application-specific blockchains within a broader blockchain environment: "You can launch application-specific chains, including those tailored for gaming, all using the C1 Zero technology. These chains can then employ inter-blockchain communication and zero-knowledge roll-ups to validate transactions." P2 affirmed this observation by referencing blockchains having the same underlying technology to enable easier adoption for enterprise applications by using an open-source platform: "We use an open-source blockchain protocol named Antelope, developed by a talented team of engineers." The shared insights from P1 and P2 highlight the versatility and adaptability of blockchain technologies, specifically through utilizing application-specific chains and open-source protocols, which are integral in fostering resilience and facilitating smoother adoption in enterprise applications.

Another aspect of resiliency discussed was the limitation of blockchain technologies and data storage. Since the blockchains require that the ledger is duplicated among a set of decentralized validators, the database exists within each validator to bring a consensus to each transaction (Yang et al., 2020). For example, P3 provided the following example: “You’re not going to be able to throw a multi-terabyte database from an enterprise onto a blockchain quite as easily.” P4 affirmed this limitation with the following observation:

> Not all data needs to be put on chain but can be cross-verified by a piece of data that is onchained. You can basically spin up a server for the period of time you need it to be this large amount of data processing.

The reflections from P3 and P4 underscore the challenges of integrating large-scale databases into blockchain technologies, emphasizing the necessity for selective on-chain data storage and validation.

The participants’ findings elucidate several strategies IT professionals employ to harness blockchain technologies for building resilient systems. As highlighted by P1 and P2, one prominent strategy is the development and utilization of application-specific blockchains within a broader blockchain environment, leveraging technologies such as C1 with Antelope. This approach, underpinned by decentralization, inter-blockchain communication, and zero-knowledge roll-ups, showcases the versatility and adaptability of blockchain, which are crucial for fostering resilience. Additionally, using open-source platforms facilitates smoother adoption, especially in enterprise applications, by ensuring that diverse applications can be easily integrated, thus enhancing the overall resilience and versatility of the systems.

On the other hand, the insights from P3 and P4 shed light on the limitations and challenges associated with blockchain technologies, particularly in data storage. The inherent requirement of blockchain for duplicating ledgers among decentralized validators poses challenges for integrating multi-terabyte databases from enterprises. This necessitates a selective approach to on-chain data storage and validation, emphasizing the need for innovative solutions to manage large-scale data while maintaining the integrity and security of the system. Strategies such as spinning up servers for temporary data processing, as suggested by P4, exemplify the adaptive measures taken by IT professionals to circumvent these challenges and ensure the resilience and functionality of blockchain-enabled systems.

Navigating the challenges and potentials of blockchain technologies, participant reflections, and strategies inadvertently intersect with Kruger’s change management theory or the change iceberg. Kruger framed change management as an iceberg: above the waterline are visible elements like technical problems, while beneath it are less observable factors like attitudes and fears that can profoundly obstruct change initiatives. Participant dialogues articulate strategies, such as selective data deployment onto blockchains (P3 and P4) and utilizing application-specific chains and open-source protocols (P1 and P2), which adeptly address visible technical challenges—the iceberg's tip. However, these strategies also illuminate sophisticated approaches toward managing overt technical aspects; their success is fundamentally linked to managing submerged elements like organizational culture and individual attitudes toward new technologies. Consequently, a nuanced exploration of Kruger's iceberg underscores the imperative to align technical strategies with a thorough comprehension and management of underlying beliefs and cultural nuances among the IT professional community and organizational environments to holistically foster and sustain resilient blockchain systems, ensuring professional strategies to bolster technical robustness and system resilience are symbiotically harmonized with organizational strategies that navigate and transform the concealed, human, and cultural dynamics.

The adoption of application-specific blockchains and open-source protocols, as discussed by P1 and P2, addresses the surface-level of the iceberg by providing technical solutions that enhance the versatility and adaptability of blockchain technologies. By employing technologies like Antelope, IT professionals manage change's visible, technical aspects, foster resilience, and facilitate smoother adoption in enterprise applications. Consequently, IT professionals are addressing immediate technological needs and navigating the broader challenges of integrating blockchain into existing organizational infrastructures, thereby aligning technical functionality with organizational strategy and operational flow. However, the insights from P3 and P4 underscored the need for innovative solutions, as integrating these technological strategies in real-world applications potentially brings forth hidden challenges. For instance, it can be difficult to establish trust in these novel approaches, reshape organizational norms around data storage and security, and redefine roles and responsibilities within the IT professional community. Hence, though the interviewees did not explicitly mention beliefs and attitudes, it is implied that successful strategy integration, as alluded to by the technical solutions of P3 and P4, would require navigating through the submerged aspects of Krüger’s iceberg to ensure coherent and sustainable implementation within an organization’s existing cultural and structural paradigm. As organizations navigate the course toward leveraging blockchain technologies for bolstering resilience, the integration of technical strategies and the concurrent transformation of underlying organizational structures and cultural norms emerge not merely as a parallel process but as a co-evolving phenomenon, where technological solutions and organizational change are intertwined in a dance, each shaping and being shaped by the other, towards fostering a resilient, secure, and privacy-preserving decentralized digital future.

Theme 2: Privacy

Blockchain technology stands at the forefront of addressing privacy concerns, offering myriad solutions to safeguard data and enhance the security of digital transactions. As the digital landscape evolves, IT professionals are exploring innovative strategies to harness blockchain’s potential to fortify privacy within systems, thus contributing to overall resilience (Zhang et al., 2019). The inherent characteristics of blockchain, such as decentralization, encryption, and immutability, serve as foundational elements in establishing secure and private environments. Privacy includes links between transactions that should not be visible or discoverable (Feng et al., 2019). With this in mind, the research question, “What strategies do IT professionals use to support blockchain technologies to enable resilient systems?” guides an exploration into the diverse approaches employed by IT professionals to leverage blockchain’s privacy features, aiming to uncover how these strategies contribute to the development of robust and resilient systems. This inquiry explored the intricate balance between transparency and privacy that blockchain presents, exploring how IT professionals navigate this dynamic to optimize system security and data protection.

When considering public blockchains, it is important to also consider that the data stored on this database are publicly exposed. For example, P2 made the following observation on privacy with blockchain networks:

> Privacy concepts in blockchain are often misunderstood. Many assume these features exist by default, but they currently don’t. While there are technological methods to introduce some level of privacy, it’s generally a situation where transactions are anonymous until they aren’t. Consider the traditional banking systems and regulations like GDPR, which prevent public disclosure of individuals’ salaries. However, if salaries were distributed via blockchain, once someone identifies an account with an employee, that salary becomes public knowledge. Thus, there are certain privacy limitations in current blockchain technologies. However, emerging tools, like zero-knowledge proofs, may offer solutions in the future.

P1 affirmed this concern with the following statement: “Large commercial industries see a lot of value in their data, and they don’t want other people to get access to it.” P4 also stated, “If your data is intended to be private. Blockchain technologies aren’t going to be private by default.” P3 further noted, “When using blockchain technology, organizations must differentiate between information that can be made public and what should remain private.” And P3 stated that he has not seen any blockchain technologies addressing privacy concerns.

When interpreting these findings through the lens of Krüger’s change management (change iceberg) theory, it becomes apparent that addressing the challenges associated with privacy in public blockchains encompasses both visible and hidden layers of change (Bedrii, 2020). Krüger’s theory underscores the importance of acknowledging not just the overt, technical challenges (the tip of the iceberg), but also the covert, deeper issues related to people’s attitudes, fears, and the organizational culture and norms (below the surface; Bedrii, 2020). In light of Krüger’s change management theory, which asserts that observable phenomena (e.g., behaviors or technologies) are frequently underscored by obscured motivational forces and structures (such as cultural paradigms and implicit regulations), privacy predicaments inherent to public blockchains may be construed not merely as a technological difficulty, but as an organizational problem that infiltrates more profound structural and cultural strata (Kruger, 2022). Participants P1 and P4 underscored a crucial observation: entities, particularly within expansive commercial sectors, prioritize their data confidentiality and exhibit an inherent hesitancy toward overt dissemination. This aversion is not merely a superficial challenge (the overt part of the iceberg in Krüger’s conceptualization) but also encompasses more cryptic, intangible apprehensions, including confidence in the technology, organizational preparedness for transparency, and potential incongruities with prevailing data protection norms, such as the General Data Protection Regulation and the California Consumer Privacy Act with implementation dates in 2018 and 2020 (Li et al., 2020).

Within the comprehensive schema of blockchain adoption, safeguarding privacy transcends the mere implementation of technological solutions. It concurrently demands an organizational metamorphosis that harmonizes with extant privacy norms and values, necessitating a navigation and potential modification of the underlying structures and cultural norms (the submerged portion of Krüger's iceberg) (Bedrii, 2020). This necessitates meticulous scrutiny and possible reconfiguration of prevailing systems, philosophies, and practices pertinent to data privacy within organizations, synchronously aligning with technological progress to ensure that privacy remains inviolate when utilizing a public blockchain. Consequently, the interview data unveil a poignant confluence where technological progression and organizational change management must amalgamate to navigate the perceptible privacy challenges proffered by blockchain technologies proficiently.

However, beneath this technical layer lie deeper, more covert challenges. The participants' concerns about the potential exposure of sensitive information, such as salaries, and the reluctance of commercial industries to share valuable data, point to underlying fears and attitudes that need to be addressed. These sentiments indicate a need for a shift in perception and understanding of privacy within the blockchain domain, which aligns with the submerged aspects of the change management theory, emphasizing attitudes, beliefs, and fears. Navigating through the narratives of P1 through P4, a palpable apprehension emerges, reflecting a trepidation toward potential inadvertent disclosure of information, revealing an inherent skepticism towards blockchain's capability to safeguard privacy – a fundamental aspect deeply ingrained within organizational culture and data management beliefs. P2's observation highlights a tangible fear: the tension between the theoretical anonymity of blockchain transactions and the stark reality that, once deciphered, these transactions become irrevocably public, thereby surfacing beliefs that privacy cannot be unequivocally assured within the current technological framework. Security and privacy of blockchains continue to be at the center of the debate when deploying blockchain in different applications (Zhang et al., 2019). P4's assertion encapsulates anticipatory anxiety grounded in the belief that despite the ostensibly private nature of blockchain, in reality, sensitive data is perpetually at risk, accentuating an overarching belief and fear matrix that privacy within the blockchain, in its present state, is paradoxically public, highlighting an urgent call for technological and organizational alignment to mitigate these concerns and navigate the treacherous waters of privacy assurance.

Moreover, the concerns expressed by P1, P3, and P4 about the limitations of existing blockchain technologies in addressing privacy reflect an organizational culture and norms aspect. Organizations and industries must undergo a cultural shift to prioritize and value privacy, aligning their norms and practices with the evolving capabilities of blockchain technologies. This transformation aligns with the deepest layer of Kruger's iceberg, requiring reevaluating values and norms to manage change successfully (Kruger, 2022). As highlighted by participants, barriers to this requisite cultural shift towards privacy encompass tangible and intangible facets, such as prevailing misunderstandings about blockchain's inherent privacy capacities and an ingrained reluctance to diverge from traditional data management frameworks due to skepticism toward new technologies. Moreover, the dichotomy between existing norms, which are primarily rooted in traditional, centralized data management systems, and the decentralized, immutable nature of blockchain erects a formidable barrier, necessitating not only a technological adaptation but also a fundamental reorientation and realignment of organizational values, beliefs, and norms toward data privacy and management in the blockchain realm.

Addressing the privacy concerns in public blockchain technologies necessitates a multifaceted approach, encompassing both technical solutions and shifts in attitudes, beliefs, and organizational culture, as highlighted by Krüger's change management theory (Bedrii, 2020). By considering and addressing both the visible and hidden dimensions of change, a more comprehensive and effective approach to managing privacy in blockchain can be realized.

As the discourse regarding privacy in blockchain technologies unfolds, a complex tableau surfaces, unveiling not just the overt technical conundrums but also the covert challenges entwined in organizational culture, attitudes, and underlying fears, effectively illuminated by Krüger's change management theory (Kruger, 2022). This exploration, steered by the insights shared by participants P1 through P4, heralds a crucial appreciation of the privacy challenges in blockchain, which although palpably technological, are also deeply interlaced with hidden dimensions of change. While blockchain presents an ostensibly decentralized and secure environment, concerns regarding the actualization of true privacy pervade, as exemplified by potential exposures of sensitive data and the tangible apprehension within industries regarding the public visibility of certain information (Feng et al., 2019).

Addressing these apprehensions and navigating through the murky waters of privacy assurance within blockchain technologies necessitates a synchronized dance between advancing technological capabilities and maneuvering through organizational changes, entailing an alignment of both the visible and submerged aspects of change (Bedrii, 2020). The subsequent path forward beckons a comprehensive alignment of technological strategies with cognizant, empathetic navigation through the existing fears, beliefs, and organizational norms that may otherwise form concealed icebergs, obstructing blockchain technologies' seamless adoption and optimization. Therefore, the task ahead for IT professionals and organizational leaders pivots on conjointly ensuring technical robustness while also crafting a navigational map that diligently addresses and steers through the submerged, often unseen, cultural and emotional terrains to holistically embed and optimize blockchain technologies within a framework that is resilient, secure, and privacy-assured.

Theme 3: Transaction Speed

In exploring blockchain technologies' role in fostering resilient systems, a pivotal consideration emerges around the impact of transaction speeds. This factor is intrinsic to the performance and efficiency of blockchain networks, influencing how swiftly data can be processed, validated, and recorded on the ledger. Slow transaction speeds can act as a bottleneck, potentially compromising the responsiveness and adaptability of the system (Li et al, 2020). In contrast, faster speeds can enhance the system's ability to manage high volumes of data and respond to challenges effectively. With the research question, "What strategies do IT professionals use to support blockchain technologies to enable resilient systems?" in focus, this study delves into the significance of optimizing transaction speeds within blockchain technologies and how IT professionals strategize to balance speed with decentralization and privacy, thereby contributing to the overall resilience of the systems they support. This exploration aims to uncover the nuanced strategies employed and the challenges encountered in harmonizing transaction speeds with the diverse demands of resilient blockchain-based systems.

Regarding migrating enterprise databases to blockchain technology, P1 makes the following observation.

> When considering migrating a Postgres database to the blockchain, it's a complex process and a significant endeavor. While it's possible to transfer a large amount of data onto a blockchain, it's time-intensive. Such a migration would immediately inflate the data for any indexers. The blockchain we've used can handle up to 15,000 EVM transactions per second.

P2 affirms this conclusion with the statement: "With decentralized execution, that whole concept of hundreds of nodes having to run all the same transactions and store all the same data. It's not really efficient to store large amounts of data on the blockchain." P3 also references the transaction speeds in comparing enterprise databases such as Postgres, in comparison with blockchain technologies with the following; "Postgres databases could process more transactions at once, compared to blockchain technologies.

Resources. P4 then asserts the transaction speed concern with blockchain technologies: "Within enterprise applications, data needs to be processed within 30 milliseconds." This is concerning when considering blockchain technologies process transactions within seconds to minutes, not milliseconds.

The observations made by the participants about migrating enterprise databases to blockchain technology can be comprehensively analyzed through Krüger's change management theory. This theory posits that successful change involves addressing the visible, technical aspects (the tip of the iceberg) and the underlying attitudes, beliefs, fears, and organizational culture and norms (beneath the surface).

At the tip of the iceberg, the technical challenges of migrating databases, such as data bloat and inefficiency in storing large amounts of data on the blockchain, are readily apparent. P1's remark on the complexity and time-consuming nature of the task and P2's affirmation of the inefficiency of decentralized execution elucidate these tangible, technical hurdles. Similarly, P3 and P4's concerns about transaction speeds further underscore the practical issues that need addressing.

Diving deeper beneath the surface, we encounter individuals' attitudes and beliefs. The participants' reflections reveal a prevailing skepticism and cautiousness regarding the feasibility and efficiency of integrating traditional databases with blockchain technology (Kruger, 2022). Addressing these concerns requires fostering a belief in the potential benefits and long-term efficiencies that blockchain can bring, even with its current limitations. Mitigating fears and cultivating a positive attitude toward the change is essential for successful implementation.

At the deepest layer, we find organizational culture and norms. The participants' observations suggest a potential clash between the established norms of enterprise applications, where data needs to be processed swiftly, and the emerging blockchain technologies. Organizations might need to reassess and realign their expectations and norms around data processing speeds and efficiency to integrate blockchain technologies successfully. Therefore, effectively managing the migration of enterprise databases to blockchain technologies necessitates a multifaceted approach. This involves addressing the overt technical challenges, transforming attitudes and beliefs about the technology, and aligning organizational norms and values with the new paradigm, as Krüger's change management theory underscored (Bedrii, 2020). A holistic and successful change management strategy can be developed by navigating through these different layers of the iceberg.

The given passage highlights the role of transaction speeds in blockchain technologies as crucial for developing resilient systems. The findings reveal specific strategies IT professionals implement to enhance transaction speeds within blockchain technologies. While prioritizing this optimization, they also meticulously navigate the intricate balance between ensuring decentralization and safeguarding privacy. In blockchain technology, decentralization refers to the distribution of control and operations across multiple nodes or participants, eliminating the need for a centralized authority. Meanwhile, privacy entails securing transactional and participant information from unauthorized access. Therefore, IT professionals engage in a delicate orchestration of strategies that amplify transactional efficiency and uphold the pivotal aspects of decentralization and privacy, ensuring that one does not undermine the other. This balance is crucial in maintaining the integrity and functionality of blockchain systems within organizational settings. The optimization of transaction speeds is portrayed as intrinsic to the efficiency and performance of blockchain networks, affecting the system's responsiveness and ability to manage high volumes of data. The passage also references the complexity of migrating traditional enterprise databases like Postgres to the blockchain, pointing out the inefficiencies in storing large amounts of data on the blockchain and the challenges in processing speeds, which are integral to enterprise applications. The transaction verification process for cryptocurrencies is much slower than traditional digital transaction systems (Hazari & Mahmoud, 2020).

Relating to the research question, "What strategies do IT professionals use to support blockchain technologies to enable resilient systems?" this passage underscores the significance of addressing transaction speed concerns in blockchain technologies. IT professionals face the challenge of harmonizing transaction speeds with the demands of resilient blockchain-based systems, particularly when migrating large enterprise databases. The insights from different professionals (P1-P4) illustrate the complexities and affirm the critical nature of transaction speeds, emphasizing the need for strategic approaches to leverage blockchain's capabilities for building resilient systems while also managing the inherent limitations and inefficiencies in data storage and processing.

In navigating the intricacies of optimizing blockchain technologies for resilient systems, transaction speeds' pivotal role, especially in migrating large enterprise databases, has been thoroughly examined. Various participant observations highlight the complexity, time-intensive nature, and inherent inefficiencies in dealing with expansive data within blockchain technologies, showcasing tangible technical challenges that IT professionals meticulously navigate. In amalgamating these insights with Krüger's change management theory, it is emphasized that beneath the overt technological challenges, deeper layers of attitudes, fears, and organizational norms significantly influence the successful implementation and management of blockchain technologies (Kruger, 2022).

The pivotal balance between ensuring data processing efficiency while maintaining decentralization and privacy propels IT professionals to conceive and implement nuanced strategies that not only address the visible, technical aspects of blockchain implementation but also gently navigate through the underlying beliefs, attitudes, and organizational norms, which can either facilitate or hinder the seamless incorporation of blockchain technologies within enterprise contexts (Bedrii, 2020). Therefore, the forward path leans towards crafting a holistic approach to implementing blockchain technologies, one that is firmly rooted in technical robustness while being tenderly entwined with an empathetic understanding and navigation through the emotional and cultural undercurrents of organizational change, ensuring that the technological adoption is not merely efficient but is also harmoniously embedded within the organizational milieu, thereby fostering genuinely resilient systems.

Applications to Professional Practice

The findings of this study provide a deep understanding of the strategies employed by IT professionals to leverage the capabilities of blockchain technologies, particularly in creating resilient systems. A core theme is the value of decentralization, marking a decisive shift away from vulnerable centralized models. By distributing data and control, decentralization not only enhances security but also promotes adaptability (Abimbola, 2019). This is further highlighted by the growing interest in application-specific blockchains and the adoption of open-source protocols, emphasizing the versatility and adaptability of blockchain technologies.

However, the study does not shy away from recognizing significant challenges. The integration of large-scale databases into blockchain technologies presents logistical difficulties due to the inherent requirement of duplicating ledgers across validators. Innovative solutions, such as temporarily activating servers for data tracking, are among the approaches used to address these issues. Furthermore, application-specific blockchains and open-source protocols are viewed as instrumental tools to enhance adaptability and resilience in the blockchain arena.

Privacy, especially in the context of public blockchains, emerges as a pressing concern. The transparent nature of these blockchains can inadvertently expose data, leading to potential breaches of privacy. Technical solutions are being explored to address these privacy concerns without undermining the decentralized essence of blockchain. The theory by Krüger, which highlights both overt and covert challenges, offers a comprehensive perspective. Beyond just technical solutions, such as the integration of features like zero-knowledge proofs, there’s a broader need to address societal attitudes, apprehensions, and the prevailing organizational culture surrounding privacy.

Performance metrics, especially transaction speeds, are vital in evaluating the practicality and efficiency of blockchain-based systems. Migrating databases presents unique challenges, and concerns arise about the potential inefficiencies inherent in decentralized execution. There’s a recognized gap in transaction speeds when comparing traditional systems to blockchain technologies. Striking a balance between speed, decentralization, and privacy is a nuanced endeavor that IT professionals strive to perfect to enhance both the resilience and performance of the systems they oversee.

In the realm of IT, particularly in implementing blockchain technologies, the applicability of Krüger’s change management theory becomes evident. On the surface, it might appear that the transition is primarily about technical integration — understanding the technological underpinnings, ensuring efficient transaction speeds, and optimizing data storage (Bedrii, 2020). These are akin to the "above water" portions of the iceberg, the overt challenges that are immediately identifiable. However, beneath these lie the more intricate, covert challenges. Adapting to blockchain technology might mean reshuffling organizational structures, addressing latent resistance from employees unfamiliar or uncomfortable with the new technology, or overcoming traditional mindsets that favor centralized over decentralized systems.

Furthermore, the deeper submerged issues — deeply ingrained organizational culture, subconscious fears, and individual concerns — resonate with the privacy challenges highlighted in the study (Bedrii, 2020). The overt challenge is to ensure data remains private and secure on the blockchain technically (Zhang et al., 2019). But beneath that, there lies the need to reassure stakeholders, change attitudes towards data transparency, and address subconscious fears about the immutability of blockchain records. In light of Krüger's theory, the true efficacy of blockchain adoption lies in addressing the overt challenges and navigating and managing the more profound, hidden aspects of change.

In conclusion, the evolving landscape of IT and blockchain technologies presents both immense potential and multifaceted challenges. The value of decentralization, emphasizing security and adaptability, remains a beacon for innovation. However, as organizations wade through these uncharted waters, they must confront visible and submerged challenges, as Krüger's change management theory articulated (Bedrii, 2020). While technical challenges demand rigorous solutions, the deeply rooted, often covert, cultural, and psychological barriers will shape the trajectory of blockchain's adoption and integration. A holistic approach, which recognizes and addresses both the explicit and implicit dimensions of change, will be pivotal in harnessing the full potential of blockchain technologies, ultimately leading to resilient, efficient, and transparent systems for the future.

Implications for Social Change

The ongoing evolution of blockchain technologies presents significant implications for social change, particularly in the domains of resilience, data security, and privacy. This evolution offers prospects for tangible improvements across individuals, communities, organizations, institutions, cultures, and societies.

Individuals and Communities

The decentralization inherent in blockchain technologies represents a profound shift away from traditional centralized systems. For individuals and communities, this decentralization can be empowering. No longer bound by a single point of control, individuals can have increased ownership and influence over their data, transactions, and digital identities (Hazari & Mahmoud, 2020). In community settings, this technology can foster a more egalitarian atmosphere, as the power and control previously held by a few can be dispersed across the community. This democratization can enhance transparency, trust, and collaboration, thereby leading to stronger, more resilient communities.

Organizations and Institutions

For businesses and institutions, the adaptability and resilience offered by blockchain technologies can lead to more robust and reliable systems. As highlighted by the research findings, IT professionals are focusing on application-specific blockchains and open-source platforms to ease adoption. The versatility of blockchain technologies ensures that organizations can maintain adaptability, recover swiftly from adverse situations, and have systems less susceptible to cyber-attacks (Feng et al., 2019). By moving away from single points of failure and employing decentralized structures, businesses can benefit from reduced downtimes, leading to increased productivity and profitability. Institutions, especially those that handle sensitive data, can implement blockchain for heightened security measures, ensuring data integrity and trust among stakeholders.

Cultures and Societies

On a broader cultural and societal scale, the challenges highlighted, especially regarding privacy concerns, represent a call for increased awareness and understanding of the implications of digital technologies. Cultures must evolve to place a premium on data privacy, demanding that digital solutions, including blockchain, uphold the highest security standards. As society becomes more digitalized, fostering a culture of privacy and security becomes paramount, ensuring that individuals' rights and freedoms are maintained in an increasingly interconnected world. Additionally, the potential limitations of blockchain, such as data storage issues and transaction speeds, remind society of the importance of continuous innovation and adaptation to technological challenges (Li et al., 2020).

Improving Public Health Outcomes

With blockchain-enhanced EHRs, patient data becomes more accessible and transparent across various health care providers. This can lead to improved medical outcomes, as health care professionals get a comprehensive view of a patient's medical history, enabling more informed decisions. Better health outcomes at the individual level can translate to healthier societies, reducing the burden on public health infrastructure and potentially lowering health care costs for individuals and governments (Abimbola, 2019).

Empowering Consumers

In supply chain systems, blockchain's transparency gives consumers the power to make informed choices. Health companies are exploring the use of blockchain, a tamperproof and distributed digital ledger, to address some of these challenges (Velmovitsky, 2021). They can trace the origin of products, which can influence purchasing decisions, especially concerning ethically produced, sustainable, or genuine products. As consumers become more conscious and demand transparency, businesses are compelled to adopt ethical and sustainable practices, driving a shift towards more responsible production and consumption.

In conclusion, the burgeoning potential of blockchain technologies, combined with the challenges highlighted, offers an intriguing backdrop for social change. While the technology promises decentralization, enhanced security, and adaptability, it also brings forth challenges that society must address. By understanding and integrating these implications, there's an opportunity to catalyze positive transformations across individuals, communities, organizations, institutions, cultures, and societies. Blockchain is not just a technological innovation; it's a driver for holistic social change.

Recommendations for Action

The findings have unequivocally emphasized the significance of decentralization in creating resilient blockchain systems. For companies and IT professionals focused on leveraging blockchain for enhanced security, decentralization should be prioritized. For increased adaptability, application-specific chains and open-source protocols such as Antelope (previously EOSIO) should be explored. Enterprises should also consider training programs to foster deeper understanding and expertise. Blockchain industry stakeholders, such as software developers, IT managers, and tech entrepreneurs, should pay close attention to these findings. A possible method for disseminating these results might be through whitepapers, IT conferences, and webinars tailored for blockchain specialists.

With respect to data storage limitations on blockchain, the inherent challenge of incorporating large-scale databases into blockchain systems has been highlighted. IT professionals and decision-makers in organizations must be selective in deciding which data should be stored on-chain and which should remain off-chain (Khan et al., 2021). Block size can affect transaction throughput and latency, which can be indirectly linked to the consensus model. This calls for developing advanced tools and strategies to manage large-scale data effectively without compromising blockchain integrity. Given the technical nature of these challenges, software engineers, database administrators, and IT strategy heads should be particularly attentive to these findings. Technical workshops and database optimization seminars might be beneficial to communicate these results.

Privacy has emerged as a critical concern in the public blockchain domain. Investing in research and development for blockchain technologies that integrate advanced privacy features, such as zero-knowledge proofs, is imperative to counter this (Li et al., 2020). Organizations must also undergo a cultural shift to recognize and prioritize the value of privacy in blockchain systems. Given the wider implications of privacy, stakeholders ranging from IT professionals to top-tier management should heed these findings. These results could be shared via industry reports, training programs, and thought leadership articles emphasizing the importance of privacy in blockchain ecosystems.

The issue of transaction speed is at the forefront of blockchain efficiency and resilience. The findings stress the need to strike a balance between speed, decentralization, and privacy. Blockchain transaction throughput decreases with the increasing number of peers that validate consensus (Khan et al., 2021). Companies should consider technological solutions and strategies to optimize transaction speeds without compromising on the core principles of blockchain. IT professionals should closely consider these findings, especially those focused on performance optimization and infrastructure management. Sharing this information through benchmark reports, performance metric dashboards, and performance improvement workshops could effectively disseminate the results to the intended audience.

In addressing the research question, "What strategies do IT professionals use to support blockchain technologies to enable resilient systems?", the findings underscore four pivotal areas: decentralization's primacy, challenges in data storage, the imperative of privacy, and the balance needed between transaction speed, decentralization, and privacy. Decentralization emerges as a cornerstone for resilience, while data storage on blockchain necessitates discernment between on-chain and off-chain data. Privacy concerns in the public blockchain domain call for both technological advancements and cultural adaptation and transaction speed's significance is weighed against the foundational principles of blockchain.

When applied to these findings, Krüger's change management theory suggests that the overt challenges, such as privacy and transaction speeds, represent just the tip of the iceberg. Beneath the surface lie more profound organizational beliefs, perceptions, and values about decentralization, privacy, and data storage. To harness blockchain's potential for resilience, IT professionals must navigate the visible challenges and the underlying cultural and attitudinal shifts, ensuring a comprehensive, in-depth approach to blockchain technology adoption and optimization (Bedrii, 2020).

Recommendations for Further Study

This study explored the pivotal role of decentralization in fostering resilience in blockchain technologies, primarily through implementing application-specific blockchains and open-source protocols. Participants P1 and P2 shared insights on the versatility and adaptability of such technologies, highlighting their potential to bolster system resilience. Given this foundational understanding, future research could delve deeper into the specific advantages and limitations of various application-specific blockchains, exploring how they cater to the unique requirements of different industry sectors. A comparative analysis of decentralized architectures, including C1's Antelope and other emerging technologies, could provide a richer perspective on optimizing resilience across various applications.

A recurring theme from participants P3 and P4 was the challenges of integrating large-scale databases into blockchain technologies. The inherent duplication of ledgers among decentralized validators poses a barrier to incorporating vast databases seamlessly (Hazari & Mahmoud, 2020). This finding points to the need for further study on innovative solutions that enable selective on-chain data storage while retaining the integrity, security, and resilience inherent to blockchain technologies. Research could explore mechanisms like temporary data servers or other adaptive storage solutions, evaluating their efficiency and scalability in real-world scenarios.

A crucial area that surfaced during this study was the privacy vulnerabilities inherent to public blockchains. While blockchain technologies promise enhanced security through decentralization, encryption, and immutability, concerns persist about the potential exposure of sensitive information, as highlighted by participants P1, P3, and P4. Further research is warranted to delve into privacy-enhancing technologies within the blockchain domain, such as zero-knowledge proofs or advanced encryption techniques. Current blockchain technologies store sensitive data on the blockchain that would be accessible to anyone, resulting in a lack of privacy (Li et al., 2020). Additionally, a study could explore how organizational cultures and norms adapt to prioritize privacy in blockchain implementations, ensuring alignment with the evolving landscape.

The balance between transaction speed, decentralization, and privacy emerged as pivotal in ensuring blockchain resilience. Slow transaction speeds could compromise a system's responsiveness and adaptability, yet increasing speed might risk compromising other resilience factors (Hazari & Mahmoud, 2019). Participants P1, P2, P3, and P4 highlighted the intricacies and challenges of this balancing act. Given the significance of this balance, future studies could explore optimization strategies that harmonize these factors. A particular emphasis could be placed on how emerging blockchain technologies manage transaction speeds, ensuring rapid data processing while retaining the benefits of decentralization and enhanced privacy.

Reflections

The research journey has been an exhilarating endeavor from a personal and professional standpoint. At the outset, I had underestimated the intricacies of identifying the study's ideal participants. This task was further complicated by the need to find participants possessing developer and infrastructure skillsets within a singular organization. Compounding this challenge was that blockchain technology, being in its nascent stages of adoption and advancement, meant that experts in the field were rare and continuously evolving in their understanding. To ensure objectivity and minimize potential influence over the study's outcomes, I stayed open-minded and strictly adhered to the predetermined interview questions. This consistency allowed me to identify recurring themes within the findings organically, ensuring that the insights drawn were genuine and uninfluenced by any leading on my part. Furthermore, engaging with such a dynamic field emphasized the importance of adaptability and resilience in research, teaching me to expect the unexpected and be prepared to pivot when necessary.

Summary and Study Conclusions

The research sought to understand strategies utilized by IT professionals in the U.S. to harness blockchain technologies for creating resilient systems. Through semi-structured interviews with security managers from two blockchain-specializing companies, the study identified decentralization as a key principle, enhancing resilience by distributing data across a network, thus reducing vulnerabilities. However, challenges emerged, such as the complexity of migrating large-scale databases to blockchains and the inefficiencies related to transaction speeds in decentralized models. This was highlighted by the blockchain's processing capacity, compared to traditional databases like Postgres, and the necessity for swift transaction times in enterprise applications. Additionally, concerns regarding the privacy of public blockchains were raised, indicating both technical challenges and deeper issues related to attitudes and organizational culture. The findings revealed limitations in current blockchain technologies, specifically related to database capacities, privacy measures, and the speed of transactions. These issues could impede an organization's transition to blockchain to establish robust systems. In Krüger's change management theory context, these challenges represent the "tip of the iceberg" or the overt technical problems. Beneath the surface, deeper challenges related to the privacy of public blockchains emerged. These concerns highlighted the technical difficulties and underlying issues connected to attitudes, fears, and organizational culture—the submerged aspects of Krüger's theory. Overall, while blockchain technologies offer notable advantages for system resilience, they also present challenges that necessitate multifaceted solutions, balancing technical adaptations with shifts in perceptions and practices.

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