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SAKARYA UNIVERSITY
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**UNDERSTANDING BLOCKCHAIN ADOPTION IN
TÜRKİYE’S SUPPLY CHAIN MANAGEMENT: A
MULTI-DIMENSIONAL ANALYSIS**

PhD THESIS

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ABBREVIATIONS

AHP	: Analytic Hierarchy Process
ANP	: Analytic Network Process
BC	: Blockchain
BCT	: Blockchain Technology
BI	: Behavioral Intention
BTA	: Blockchain Technology Adoption
CEO	: Chief Executive Officer
CIO	: Chief Information Officer
COO	: Chief Operating Officer
CRM	: Customer Relationship Management
DEMATEL	: Decision-Making Trial and Evaluation Laboratory
DLT	: Distributed Ledger Technology
DOI	: Diffusion of Innovations
EE	: Effort Expectancy (Çaba Beklentisi)
ERP	: Enterprise Resource Planning
FC	: Facilitating Conditions
GPS	: Global Positioning System
IBM	: International Business Machines Corporation
IEEE	: Institute of Electrical and Electronics Engineers
INNO	: Innovation
IP	: Intellectual Property
IS	: Information Systems
ISM	: Interpretive Structural Modeling
IT	: Information Technology
MNE	: Multinational Enterprise
PBFT	: Practical Byzantine Fault Tolerance
PE	: Performance Expectancy
PEOU	: Perceived Ease of Use
PLS	: Partial Least Squares
PU	: Perceived Usefulness
RFID	: Radio Frequency Identification
RII	: Relative Importance Index
ROI	: Return on Investment

SAP	: Systems Applications and Products
SC	: Supply Chain
SCM	: Supply Chain Management
SEM	: Structural Equation Modeling
SI	: Social Influence
SLR	: Systematic Literature Review
SME	: Small and Medium Enterprises
TAM	: Technology Acceptance Model
TOE	: Technology-Organization-Environment Framework
TPB	: Theory of Planned Behavior
TRA	: Theory of Reasoned Action
UTAUT	: Unified Theory of Acceptance and Use of Technology

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ABSTRACT

Özsoy, S. (2025). *Understanding blockchain adoption in türkiye's supply chain management: a multi-dimensional analysis* (Unpublished doctoral thesis). Sakarya University.

Blockchain technology is recognized as a fundamental technology with the power to transform supply chain management through decentralization, transparency and reliability. It has the potential to overcome supply chain complexity and reduce risks by providing data security, traceability and operational efficiency. However, low adoption rates at the enterprise level necessitate a detailed examination of the factors and contextual dynamics that influence the adoption of this technology. This study aims to identify the key factors influencing the adoption of blockchain technology in supply chain management in Türkiye, categorize and prioritize these factors based on TAM, UTAUT, TOE and DOI theoretical frameworks. It also aims to analyze contextual dynamics and develop actionable strategies based on expert perspectives to support the process.

The research was conducted in a three-stage methodology. In the first stage, 50 critical factors for the adoption of blockchain technology were identified through the Systematic Literature Review (SLR) method and these factors were classified under five main categories: technological, organizational, environmental, innovation-specific and individual. In the second stage, the importance of these factors in the Turkish context was evaluated through ranking analysis in line with expert opinions. In the third stage, qualitative data obtained through semi-structured interviews were analyzed, contextual and perceptual dynamics were elaborated and strategies were developed.

The research findings revealed that factors such as organizational leadership, lack of technical knowledge, scalability issues and cultural resistance are determinants of blockchain adoption. In the Turkish context, regulatory uncertainties, centralized governance structures, and media-driven misperceptions stand out as important factors that hinder the adoption of the technology. In addition, lack of technical infrastructure and high costs are significant obstacles, especially for SMEs, while the outsourcing of skilled human resources abroad has limited the sustainability of projects.

In line with these findings, strategies such as organizing awareness and training programs, clarifying the regulatory framework, supporting pilot projects and increasing financial incentives have been developed. It is also recommended to implement cultural transformation programs that encourage a shift from centralized governance structures to collaborative processes.

The study offers theoretical, methodological and practical contributions. Theoretically, it adds contextual richness to blockchain adoption theories. Methodologically, the integration of quantitative and qualitative approaches provides a multidimensional analysis. Practically, a broad set of strategies is proposed, ranging from regulatory reforms to cultural transformation programs. These strategies aim to contribute to the sustainability of technological transformation by promoting the adoption of blockchain technology in Türkiye's supply chain.

Keywords: Blockchain, Supply Chain Management, Technology Adoption, Adoption Barriers, Adoption Strategies

ÖZET

Özsoy, S. (2025). *Türkiye tedarik zinciri yönetiminde blokzinciri benimsenmesinin anlaşılması: çok boyutlu bir analiz* (Yayımlanmamış Doktora Tezi). Sakarya Üniversitesi.

Blokzinciri teknolojisi, merkeziyetsizlik, şeffaflık ve güvenilirlik gibi özellikleriyle tedarik zinciri yönetimini dönüştürme gücüne sahip temel bir teknoloji olarak değerlendirilmektedir. Bu teknoloji, veri güvenliği, izlenebilirlik ve operasyonel verimlilik sağlayarak, tedarik zincirindeki karmaşıklığın üstesinden gelme ve riskleri azaltma potansiyeli taşımaktadır. Ancak, kurumsal düzeyde benimsenme oranlarının düşük seviyelerde kalması, bu teknolojinin benimsenmesini etkileyen faktörlerin ve bağlamsal dinamiklerin detaylı bir şekilde incelenmesini gerekli kılmaktadır. Bu çalışma, Türkiye'nin tedarik zinciri yönetiminde blokzinciri teknolojisinin benimsenmesine etki eden temel unsurları belirlemeyi, bu unsurları TAM, UTAUT, TOE ve DOI teorik çerçevelerine dayalı olarak kategorize etmeyi ve önceliklendirmeyi amaçlamaktadır. Ayrıca, bağlamsal dinamikleri analiz ederek, süreci desteklemek için kanıta dayalı stratejiler geliştirmek hedeflenmektedir.

Araştırma, üç aşamalı bir yöntemle gerçekleştirilmiştir. İlk aşamada, Sistematik Literatür Taraması (SLT) yöntemiyle blokzinciri teknolojisinin benimsenmesine ilişkin 50 kritik faktör belirlenmiş ve bu faktörler teknolojik, organizasyonel, çevresel, yeniliğe özgü ve bireysel olmak üzere beş ana kategori altında sınıflandırılmıştır. İkinci aşamada, uzman görüşlerine dayalı bir sıralama analiziyle bu faktörlerin Türkiye bağlamındaki önemi değerlendirilmiştir. Üçüncü aşamada ise yarı yapılandırılmış görüşmelerle elde edilen nitel veriler analiz edilmiş, bağlamsal ve algısal dinamikler detaylandırılmış ve sürece yönelik stratejiler geliştirilmiştir.

Araştırma bulguları, organizasyonel liderlik, teknik bilgi eksikliği, ölçeklenebilirlik sorunları ve kültürel direnç gibi faktörlerin blokzinciri teknolojisinin benimsenmesinde belirleyici olduğunu ortaya koymuştur. Türkiye bağlamında, düzenleyici belirsizlikler, merkeziyetçi yönetim yapıları ve medya kaynaklı yanlış algılar, teknolojinin benimsenmesini zorlaştıran unsurlar arasında yer almaktadır. Ayrıca, teknik altyapı eksikliği ve yüksek maliyetler, özellikle KOBİ'ler için önemli engeller arasında yer alırken, yetenekli insan kaynağının yurtdışına yönelmesi, projelerin sürdürülebilirliğini sınırlamaktadır.

Bu bulgular doğrultusunda, farkındalık ve eğitim programlarının hayata geçirilmesi, düzenleyici çerçevenin netleştirilmesi, pilot projelerin desteklenmesi ve finansal teşviklerin artırılması gibi stratejiler geliştirilmiştir. Bunun yanında, merkeziyetçi yönetim yapılarından iş birliğine dayalı süreçlere geçişi teşvik eden kültürel dönüşüm programlarının uygulanması önerilmektedir.

Bu çalışma, teorik, metodolojik ve pratik düzeylerde katkılar sunmaktadır. Teorik olarak, mevcut kabul teorileri genişletilmiş ve Türkiye bağlamına özgü dinamikler entegre edilmiştir. Metodolojik olarak, nicel ve nitel yaklaşımların entegrasyonu, çok boyutlu bir analiz sağlamıştır. Pratik olarak ise düzenleyici reformlardan eğitim programlarına, pilot projelerden teşvik mekanizmalarına kadar çeşitli stratejiler önerilmiştir. Bu stratejiler, Türkiye'nin tedarik zincirinde blokzinciri teknolojisinin benimsenmesini teşvik ederek, teknolojik dönüşümün sürdürülebilirliğine katkıda bulunmayı hedeflemektedir.

Anahtar Kelimeler: Blokzinciri, Tedarik Zinciri Yönetimi, Teknoloji Benimsenmesi, Benimseme Engelleri, Benimseme Stratejileri

INTRODUCTION

Throughout history, technological advances have led to radical transformations in the functioning of societies and economies, reshaping existing systems either by improving or radically changing them. Blockchain technology stands out as an innovative technology that has emerged in recent years and has attracted the attention of both academic circles and industrial actors alike with its remarkable features. One of the most prominent features of this technology is its structure based on the principle of “decentralization”. Based on decentralization, blockchain technology offers the potential to go beyond nation-state systems and traditional economic structures. Moreover, as a disruptive force, this technology has the capacity to radically transform existing systems (Frizzo-Barker et al., 2021; Queirozet al., 2020; Janssen et al., 2020) and reshape the foundations of social and economic systems (Iansiti & Lakhani, 2017; Treiblmaier, 2018).

Blockchain technology has a number of key features such as immutability, transparency, programmability, decentralized consensus, distributed trust, and permitted/unpermitted access privileges (Clohessy & Acton, 2019). Blockchain was first introduced in 2008 with the Bitcoin. While it is mostly associated with Bitcoin, blockchain goes far beyond this single application and offers a wide range of potential use cases. Blockchain is essentially defined as a platform that enables peer-to-peer transactions without the need for any intermediary (Kamble et al., 2019). This technology functions as an open and distributed ledger system and records transactions in an efficient, verifiable and persistent manner (Iansiti & Lakhani, 2017).

Decentralization, security, auditability and smart contract features distinguish blockchain technology from other information systems (Sabeti et al., 2019). These features have transformative potential, especially in supply chain operations that generate complex structures and large amounts of data (Kshetri, 2018). Supply chains encompass various elements such as customers, suppliers and geographical locations that creates challenges for data management (Fosso Wamba et al., 2020). Blockchain technology, on the other hand, combines database, data analytics and cryptography to provide a common source of information to supply chain stakeholders and increase operational efficiency (Deng et al., 2022). By providing access to real-time information, securing transactions, and eliminating the need for third-party verification, it reduces uncertainties and risks in the supply chain (Clohessy & Acton, 2019).

With these features, blockchain technology is considered as a strategic tool for organizations in terms of providing transparency, traceability and verifiable information in supply chain networks (Kumar Bhardwaj et al., 2021; Chittipaka et al., 2023). However, despite all its advantages, it is seen that the adoption rates of blockchain technology at the corporate level are quite low (Queiroz & Fosso Wamba, 2019). This situation enhances the importance of examining the factors affecting the adoption of the technology and developing strategies to overcome these obstacles.

In the literature, it is emphasized that studies on the adoption of blockchain technology in supply chains are still in their infancy (Wang et al., 2019; Fosso Wamba et al., 2020; Frizzo-Barker et al., 2020). These studies state that the adoption process may vary from country to country and from sector to sector, so comprehensive research should be conducted by taking into account economic, socio-cultural and geographical differences (Dehghani et al., 2022; Alazab et al., 2021; Vafadarnikjoo et al., 2023; Choi et al., 2020).

In this context, to increase the adoption rate of blockchain technology, it is critical to identify the obstacles and develop strategies to overcome them. The main topic of this study is the adoption of blockchain technology in the context of supply chain management (SCM), and the purpose, importance, theoretical background, methodology, contributions and limitations will also be discussed accordingly.

Purpose of the Study

This dissertation purposes to identify, categorize, and prioritize the key elements affecting the adoption of blockchain technology in Türkiye's SCM while revealing contextual dynamics and formulating actionable strategies based on expert perspectives to support this process. With this purpose, the following research questions have been formulated.

RQ1: What are the critical factors affecting the adoption process of blockchain technology in Turkish supply chain management? How can these factors be categorized based on TAM, UTAUT, TOE, and DOI frameworks?

RQ2: Which factors should be prioritized in the adoption process of blockchain technology in supply chain management in Türkiye, and do the importance levels of these factors vary according to different expert profiles (academia, private sector, public sector)?

RQ3s:

RQ3a: What are the contextual and perceptual dynamics underlying the adoption of blockchain technology in Türkiye's supply chain management?

RQ3b: What new factors influencing adoption can be identified through qualitative insights?

RQ3c: What actionable strategies based on expert perspectives can be proposed to address these barriers and accelerate blockchain adoption in Türkiye

Based on these questions, it is aimed to provide a comprehensive analysis to promote and expand the adoption of blockchain technology in Türkiye's SCM practices.

Importance of the Study

Blockchain technology is an innovation that has rapidly spread in different sectors in recent years and has great potential especially in SCM. The size of the globally distributed ledger market is expected to exceed 103 billion dollars by 2030 (Statista, 2024). This growth clearly demonstrates the critical role of technology in providing transparency, traceability and accountability in supply chains.

Blockchain technology, which is widely used in the financial sector, is not only limited to applications such as digital currency (57%) and secure information exchange (53%), but is also increasing its impact in areas such as regulatory compliance (47%), asset tokenization (46%) and document digitization (43%) (Statista, 2024). This shows that blockchain technology is a versatile tool that can support complex ecosystems such as supply chains beyond financial transactions.

The massive global investment in this technology clearly highlights its growing importance and potential impact across various sectors. In 2021, spending on blockchain solutions reached \$6.6 billion and is expected to reach \$19 billion in 2024. It is also stated that 36% of organizations plan to invest more than \$5 million in this technology in 2020 (Statista, 2024). This data reveals that blockchain is gaining an increasingly important place in the strategic goals of every businesses.

In the context of SCM, blockchain technology is seen as one of the most critical tools of the future. In a 2018 survey, 41% of respondents reported significant investment in this area, while 40% reported moderate investment (Statista, 2024). This interest confirms the potential of blockchain to provide transparency, security and operational efficiency.

Also noteworthy is blockchain's potential to contribute to circular economy and sustainability goals. According to a 2019 study, only 8% of companies are actively using

blockchain, while 38% plan to adopt it in the next five years (Statista, 2024). This suggests that the technology will play an increasingly important role in circular economy activities.

In this context, blockchain technology stands out as an innovative tool with the capacity to transform SCM and other sectors. Increasing investments and diversity of applications are accelerating the pace of adoption of this technology and will further consolidate its impact in the future. However, despite the transformational potential that blockchain technology promises, the challenges and obstacles faced in the adoption process have not been sufficiently examined in the Turkish context, and more in-depth analysis and comprehensive research are needed.

Theoretical Background of the Study

Since the objectives of this dissertation are related to the adoption of blockchain technology, the Theory of Diffusion of Innovations (DOI) (Rogers, 1995), the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and the Technology-Organization-Environment (TOE) Framework (Tornatzky & Fleischer, 1990) are adopted as the theoretical framework. The adoption of technological innovations is based not only on the characteristics of the technology but also on internal organizational and external environmental factors (Tornatzky & Fleischer, 1990). Therefore, in addition to UTAUT, which addresses adoption at the individual level, the TOE framework, which examines adoption at the organizational level, was also utilized.

TAM considers two main variables, perceived usefulness and perceived ease of use, to assess individuals' attitudes and behavioral intentions towards technology. UTAUT, as an extended version of TAM, examines technological adoption at the individual level within the framework of performance expectancy, effort expectancy, social influence and facilitating conditions and evaluates moderator variables such as gender, age, experience and voluntary use (Venkatesh et al., 2003). In contrast to these approaches that focus on adoption at the individual level, the TOE framework explains the adoption of technological innovations at the organizational level. TOE offers the opportunity to assess the technology adoption decisions of organizations in a holistic manner by considering technological, organizational and environmental contexts. The technological context includes variables related to both internal and external technologies and their characteristics, while the organizational context includes internal characteristics such as organizational structure, resources and human capital. The environmental context focuses

on external factors such as the regulatory environment, market conditions and competitors.

DOI theory focuses on the nature of innovation in the adoption process. According to DOI, the adoption of a new technology is explained by factors such as relative advantage, technology compatibility, technology complexity, observability of innovation and technology trialability (Rogers, 1995).

These theoretical approaches provide a comprehensive understanding of technology adoption processes at the individual and organizational level and provide a solid foundation for examining the adoption of blockchain technology in the Turkish context.

Research Gap

Despite the growing literature on the adoption of blockchain technology in SCM, there are still some critical gaps that remain unaddressed. First, existing studies often focus on the potential benefits and application areas of blockchain technology, but there is limited research on the systematic identification and prioritization of barriers to its adoption. There is a lack of comprehensive and contextualized research on blockchain adoption, especially in emerging economies such as Türkiye. Most of the existing studies focus on developed countries and their regulatory, economic and technological infrastructures differ from those of countries like Türkiye (Dehghani et al., 2022; Alazab et al., 2021). This geographical limitation makes it difficult to directly apply global findings to the unique challenges faced by organizations in Türkiye.

Secondly, previous research often addresses blockchain adoption through a single theoretical framework and uses frameworks such as the TAM or TOE. However, blockchain adoption is a complex process in which technological, organizational and environmental factors interact with each other (Wang et al., 2019; Treiblmaier, 2018). In this context, most of the existing research does not sufficiently incorporate holistic approaches that combine different theoretical perspectives.

In addition, there is a lack of large-scale empirical studies covering the perspectives of academia, private sector and public institutions in studies on blockchain adoption. Most studies are based on the views of a limited number of stakeholders and do not fully reflect the multidisciplinary nature of blockchain technology (Queiroz et al., 2020). This study

aims to provide a more comprehensive and detailed understanding of blockchain adoption by engaging experts from different sectors.

Finally, there is limited research on the contextual and perceptual factors affecting blockchain adoption in the Turkish context. Cultural and regulatory differences play a critical role in the diffusion of new technologies, yet existing studies do not adequately focus on these elements (Choi et al., 2020; Vafadarnikjoo et al., 2023). This research aims to fill this gap by deeply analyzing the contextual dynamics influencing blockchain adoption in SCM in Türkiye.

By addressing the aforementioned gaps, this study aims to make theoretical and practical contributions to the literature and develop strategic recommendations to facilitate blockchain adoption in the supply chain sector in Türkiye.

Methodology of the Study

This study adopted a three-stage research design to understand the barriers to the adoption of blockchain technology in SCM. This systematic nature of the research enabled both the identification of critical factors from a broad literature base and an in-depth examination of these factors through expert interviews and qualitative analysis.

In the first stage, the Systematic Literature Review (SLR) method was applied to identify critical factors for blockchain technology adoption. SLT is the process of comprehensively and objectively assessing the existing literature on a specific research question or phenomenon (Tranfield et al., 2003; Kitchenham et al., 2010). This method was deemed appropriate to establish the theoretical basis of the study and to identify the critical factors that will guide the research. The research was conducted on articles published from 2009 to 2022 in Scopus database was used. The year 2009 was chosen as the starting point because blockchain technology was introduced in 2008 with Satoshi Nakamoto's article "A Peer-to-Peer Electronic Cash System". As a result of the literature review, 50 critical factors related to blockchain adoption were identified and these factors were classified under five main categories as "technological", "organizational", "environmental", "innovation-specific" and "individual" using TAM, TOE, UTAUT and DOI theories. These categories formed the theoretical framework of the study and provided the basis for the subsequent stages.

In the second stage, the Ranking Analysis method was applied to prioritize the critical factors affecting the adoption of blockchain technology in the Turkish context. The 50 factors in five categories obtained from the Systematic Literature Review were rated by the experts using a Likert-type scale from 1 (Not at All Important) to 10 (Very Important). The expert group consisted of individuals selected from academia, private and public sectors, specializing in different disciplines such as technology, logistics, finance, law and public policy. The diversity of the participants aimed to reflect the multidisciplinary nature of blockchain technology and to ensure that different perspectives are considered. The Relative Importance Index (RII) method was used to analyze expert opinions. The RII method was applied to determine the degree of importance of each factor both within the category and in the overall ranking.

Although the quantitative phase provided a comprehensive analysis of critical factors and their relative importance, this process was limited in understanding perceptual and contextual dynamics. The ranking analysis was effective in terms of prioritizing factors, but could not answer the questions of why experts considered certain factors more important or how the context of these factors in practice was shaped. To address these shortcomings, the addition of a qualitative phase was deemed necessary.

In the third stage, the qualitative analysis explained and contextualized the quantitative findings in depth and elaborated on the perceptual and contextual foundations behind the factors that stood out in the ranking. In addition, new factors and strategies specific to the Turkish context were identified in this process. Türkiye's unique economic, cultural and technological dynamics have been taken into account, revealing elements that have not yet been addressed in the literature.

In this stage, semi-structured interview technique was preferred. This technique adheres to a basic question guide, but allows for a better understanding of participants' experiences and perspectives by adding flexible questions when necessary. The interviews were conducted with 12 experts from variety of sectors, with a range of experience in logistics, software, public policy and finance. Their experience ranged from 10 to 34 years, and this diversity enhanced the scope of the information gathered.

The data obtained from the interviews were analyzed using Focused Interview Analysis (Rädiker & Kuckartz, 2020). The analysis process was carried out systematically using MAXQDA software. First, main categories were created (e.g. barriers to adoption and

solution suggestions) and then these categories were divided into subcategories. During the coding process, participant statements were carefully analyzed and classified into categories. This process enabled the findings to be visualized in a systematic way and provided the basis for explaining the theoretical and practical contributions of the study.

This three-stage methodology provided both broad and contextual insights into the adoption of blockchain technology, supporting the theoretical and practical contributions of the research. The results are discussed holistically in the discussion section, combining quantitative and qualitative analysis.

Contribution of the Study

This dissertation makes significant contributions at both theoretical, methodological, and practical levels by addressing the to the adoption of blockchain technology in SCM and strategies to overcome these barriers.

Theoretically, the study not only validates existing theories of barriers technology adoption but also adds new context-specific dimensions to them. Theories such as the TAM, the Technology-Organization-Environment Framework (TOE) and the Unified Theory of Technology Acceptance and Use (UTAUT) are supported and extended. In particular, Türkiye-specific variables such as regulatory uncertainty, cultural dynamics and media influence are integrated into these theories. The study also contributed to the literature by discussing the concept of “Blockchain Mindset” and exploring elements such as decentralization, transparency, and collaborative cultural transformation. The findings in the Turkish context fill the gaps in the literature on the factors affecting the adoption of blockchain technology in developing countries, such as resource gaps, regulatory challenges and cultural dynamics.

Methodologically, the study developed an integrated model by combining UTAUT, DOI and TOE theories. This model provides a comprehensive approach to blockchain technology adoption by combining technological, organizational, environmental, individual and innovation-specific factors. In the study, ranking analysis using the Relative Importance Index (RII) method was combined with qualitative interview analysis, thus integrating quantitative and qualitative methods to perform a multidimensional analysis. Systematic analysis using MAXQDA software provided a clearer picture of the themes and categories of blockchain adoption.

In terms of practical contributions, the study provided strategic recommendations to promote the adoption of blockchain technology in Türkiye. Concrete recommendations, such as top management support, regulatory improvements, and addressing the lack of technical knowledge, provide guidance for both the public and private sectors. In addition, the effects of individual factors on the adoption process are discussed in depth, detailing the role of technology biases, uncertainties and media influence on perceptions. These findings contribute to a better understanding of individual and organizational dynamics in the technology adoption process.

At the policy and regulatory level, the study shows that regulatory uncertainty undermines trust in blockchain technology, while regulatory support mechanisms can accelerate the adoption process. Particularly in the Turkish context, the negative effects of bureaucratic barriers and regulatory gaps on technology adoption are highlighted, and concrete recommendations for improving regulations and increasing public-private sector cooperation are presented.

As a result, this dissertation is consistent with the existing literature and makes unique contributions to the Turkish context. While general issues such as top management support, technological complexity, regulatory support, perceived benefits, privacy and security concerns, and technological immaturity are frequently emphasized in the literature, this study addresses the impact of regulatory and cultural factors in more detail. In particular, the impact of regulatory uncertainties on trust and how cultural dynamics complicate the adoption of decentralized structures have not been sufficiently discussed in the literature. They are addressed with new perspectives in this study. In addition, how individual factors shape perceptions towards blockchain technology has been examined in depth, filling in the missing knowledge in these areas.

Study Limitations

This study has some limitations and their impact on the research findings was evaluated. Furthermore, recommendations for future studies are provided to overcome these limitations and further to develop the literature on the adoption of blockchain technology.

First, the sample size of the study is one of the limitations. The research is based on a limited group of participants who are experts in the field of blockchain technology and SCM. Findings based on these expert opinions may not fully reflect the perspectives of stakeholders in different sectors or areas of expertise. In particular, the differences in the

blockchain adoption process between SMEs and large enterprises should be examined with a larger sample. However, since the aim of the study was to identify the general acceptance factors in the Turkish context, no sector-based limitation was made. General evaluations and descriptive statistics were presented in line with the sectoral information received from the participants. Nevertheless, the inability to analyze the differences between sectors in depth is considered as an important limitation.

Second, the regional focus of the study is limited to Türkiye. Due to the economic, regulatory and cultural dynamics in Türkiye, the direct generalizability of the findings for other countries is limited. Blockchain adoption processes in different countries may differ significantly from the findings of this study. Therefore, it is recommended to overcome this limitation by conducting international comparative studies in the future.

Methodological limitations also constitute an important dimension of the study. Quantitative and qualitative methods were used together in this study. While this approach provides contextual depth, the subjective nature of participants' comments may limit the generalizability of the findings. Especially, when qualitative data based on expert opinions are not supported by other methods, the accuracy of some results may be open to debate. In the future, the integration of different methodological approaches in such studies may increase the validity of the findings.

Time and resource constraints are another limitation of this study. The research was conducted over a specific time period and could not fully reflect the rapidly changing nature of blockchain technology. The continuous evolution of technological innovations may limit the validity of the factors considered in this study over time. Therefore, long-term and dynamic analysis is important for future research.

Finally, there are some limitations in terms of the factors that the study focuses on. While the research provides a broad framework for blockchain adoption, issues such as energy consumption, sustainability and social impacts are addressed in a limited way. Furthermore, the lack of in-depth examination of differences across sectors narrows the scope of the research. In the future, it is recommended to investigate blockchain adoption barriers and overcoming strategies in different sectors through case studies.

In line with these limitations, larger and more diverse samples, contextual comparisons from different countries and in-depth sector-based analyses would be useful for future studies. In particular, case studies and international comparisons where sectoral dynamics

are examined in detail can make significant contributions to the literature on the adoption of blockchain technology. These recommendations are detailed in the conclusion section of the thesis.

This thesis consists of four main chapters following the **Introduction**.

Chapter 1 deals with blockchain technology and SCM in a conceptual framework. In this chapter, firstly, the basic definition of blockchain technology is given and then the role of blockchain-based applications in SCM is emphasized. The potential benefits and challenges of blockchain technology in SCM are detailed, and examples of existing applications in this field are given.

Chapter 2 focuses on the adoption of blockchain technology in the context of supply chain. This chapter first sets out the theoretical foundations of the study and explains the theoretical frameworks associated with blockchain technology adoption. The literature review provides an overview and critical appraisal of the academic literature. In this way, key gaps and areas of debate in the literature on blockchain adoption are highlighted.

Chapter 3 is dedicated to the methodology of the study. In this chapter, the research problem, research design and methodology are explained in detail. The research was conducted within the framework of a three-stage methodological approach. In this context, the Systematic Literature Review, the quantitative research method of Ranking Analysis and the qualitative research method are detailed under separate headings. The methodology followed at each stage and the process of reaching the findings are clearly stated.

Chapter 4 is the chapter where the research results are presented and discussed. In this chapter, quantitative and qualitative findings are reported separately, and then these findings are compared and synthesized under the heading “Discussion”. The results are discussed in combination with the implications for the adoption of blockchain technology in SCM in the Turkish context.

Finally, the **Conclusion and Recommendations** section starts with an overview. In this section, theoretical and practical implications are presented and the limitations of the study are discussed in detail. In addition, future research recommendations for improving the literature on the adoption of blockchain technology are presented.

CHAPTER 1. BLOCKCHAIN TECHNOLOGY AND SUPPLY CHAIN MANAGEMENT

Numerous academic studies have substantiated the potential of blockchain technology to enhance SCM. With its inherent features, blockchain offers solutions to various supply-chain challenges. This chapter will explore the interaction between blockchain technology and SCM, its application areas, and the concept of blockchain-integrated SCM. The chapter is divided into two main sections to ensure a comprehensive understanding. The first section focuses on introducing blockchain technology. After thoroughly examining blockchain's features, the second section will delve into blockchain-integrated SCM. Additionally, this chapter will address blockchain's potential benefits and implementation challenges.

1.1. Blockchain: Evolution, Types, and Key Characteristics

Blockchain technology first gained attention with the emergence of Bitcoin, a decentralized digital currency developed by Satoshi Nakamoto in response to the 2009 global financial crisis (Nakamoto, 2008). Operating independently from government control, banks, and other financial institutions, Nakamoto described Bitcoin as "a chain of digital signatures functioning as electronic money." Nakamoto's paper demonstrated the feasibility of a data recording system resistant to manipulation without a central authority (Usta & Doğantekin, 2017).

This section will examine various definitions and the structure of blockchain technology to provide a deeper understanding. The evolution of blockchain technology will then be discussed, followed by an overview of different types of blockchain networks. Finally, the section will explore the prominent features of blockchain, including decentralization, distributed ledger technology (DLT), transparency, immutability, traceability, programmability, anonymity, and privacy.

1.1.1. Blockchain Technology

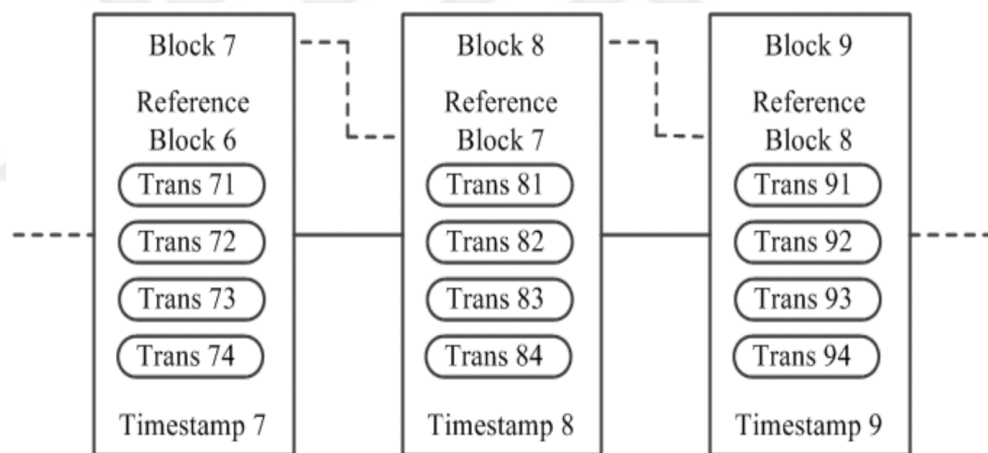
Blockchain technology is a decentralized and peer-to-peer system that guarantees the ownership and authenticity of digital assets through cryptographic verification. This technology uses a decentralized database to authenticate, assign timestamps, and

permanently document transactions. It utilizes consensus techniques to guarantee the reliability and accuracy of this database (Lacity, 2018).

Blockchain is a chronological sequence of blocks, each containing interconnected data. A block comprises a header and a body: the header includes the previous block's hash to maintain chain integrity, while the body holds essential information like transaction details (labeled as trans in Figure 1). In applications like Bitcoin, blocks record transaction data released by network nodes, encompassing sender and recipient IDs, amounts, timestamps, and more. Besides, each block also includes its ID and a link to the previous block (labeled as Reference in Figure 1). Once validated and added, these blocks form an immutable chain across the network, ensuring database transparency and reliability (Wu & Tran, 2018). The structure of Blockchain is shown in Figure 1.

Figure 1

Blockchain's Structure



Source: Wu & Tran (2018)

Mougayar (2016) defines blockchain from three different perspectives. Technically, blockchain is viewed as a backend database maintaining a distributed ledger. From a business perspective, it is a network that enables direct exchange of transactions, value, and assets between peers without intermediaries. From a legal perspective, it is considered a system that verifies transactions rather than relying on historically reliable assets.

Blockchain transactions involve the transfer of one or more assets. Transactions may involve financial payments or the exchange of information. A cryptographic hash function produces transaction hashes that encrypt the content of transactions. These hashes can be viewed on the public blockchain but cannot be used to reconstruct the

transaction. Miners verify blocks of transactions, and the verified blocks are added to the blockchain. Blockchains operate in an entirely distributed manner without a central authority. Blocks are interconnected, so transactions cannot be modified or canceled. Increasing the length of the chain makes it harder to modify blocks and increases security (Treiblmaier, 2018).

Treiblmaier(2018) defines blockchain as “a digital, decentralized, and distributed ledger where transactions are recorded in chronological order and aim to create immutable records.” Decentralization means no single entity processes transactions, while distribution means multiple computers share the computational effort. A specific owner or user group owns permissioned and private ledgers. Permissioned, publicly shared ledgers are available to the public, and trusted ledgers ensure integrity. In the last type of publicly shared ledgers, trustless consensus of users ensures integrity.

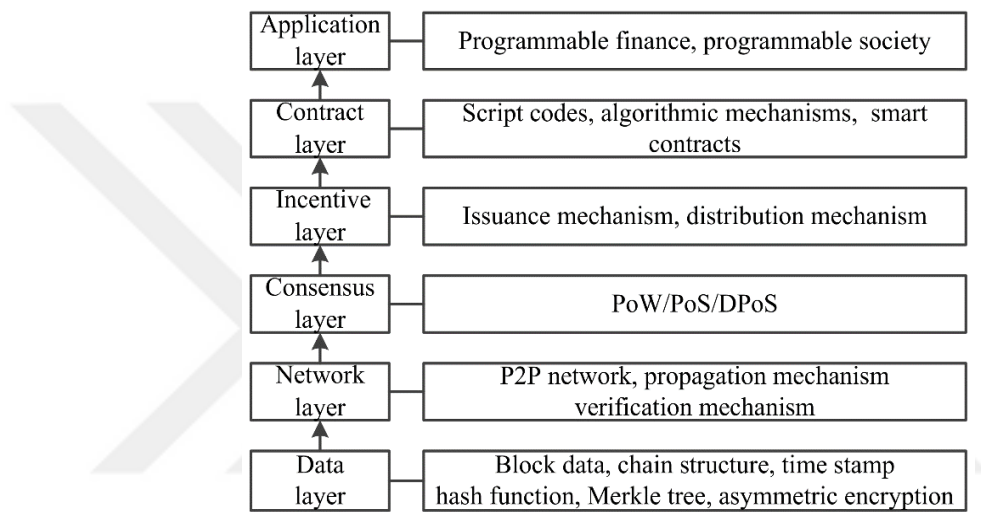
In a blockchain system, a ledger records transactions made over a period of time, forming a 'block'. After each transaction occurs, it is added to a block. Each block is linked to the blocks before and after it. Blocks in blockchains are linked together using a hash function, which can be considered a digital fingerprint of the data. This fingerprint is used to secure data within the blockchain. When these blocks are linked together in a sequence, they become immutable: They cannot be modified or removed by a single participant. Instead, it is verified and controlled through automated processes and standard management protocols. The verification process is performed by blockchain nodes, which are machines or individuals that actively participate in a blockchain network. Each node keeps a comprehensive record of all transactions on the blockchain. There is no single node that has control over the data. When a new transaction or an adjustment to an existing transaction is added to the blockchain, typically, most nodes in the network must execute algorithms to evaluate and verify the history of the proposed block. If a significant number of nodes decide that the history and signature are valid, the new transaction block is accepted into the ledger, and a new block is added to the transaction chain (Wang et al., 2019).

The blockchain technology architecture, illustrated in Figure 2, comprises several layers: the data layer, network layer, consensus layer, incentive layer, contract layer, and application layer (Wu & Tran, 2018). The data layer stores transaction records in blockchain format, including data blocks and timestamps. The network layer utilizes

peer-to-peer (P2P) network technology for transmission, propagation, and verification mechanisms alongside consensus algorithms and encrypted signatures. The consensus layer ensures efficient agreement among decentralized nodes on block validity. The incentive layer integrates economic mechanisms to incentivize computing power contributions, while the contract layer manages script codes, algorithmic mechanisms, and smart contracts for regulated contract specifications.

Figure 2

Blockchain's Technological Architecture



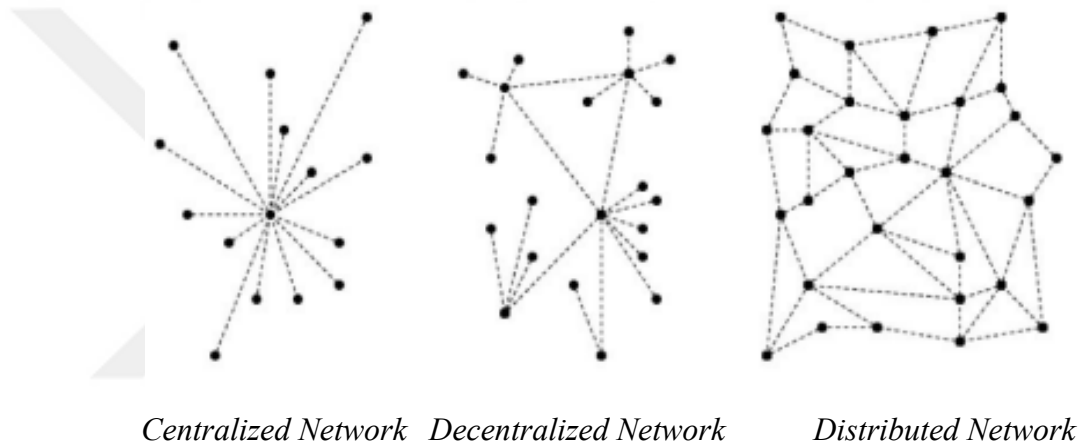
Source: Wu & Tran (2018)

Blockchain-based systems enable commercial interactions between interested parties without needing a trusted intermediary. Blockchains can function as records and inventories for comprehensive documentation, tracking, surveillance, and transaction of various assets (Wang et al., 2019). The meaning of blockchain technology varies depending on its evolving nature and the various applications in which it is used. According to Iansiti and Lakhani (2017), blockchain is a public and decentralized system that records transactions between two parties in a verifiable and permanent way. According to Treiblmaier (2018), blockchain is a digital, decentralized, distributed ledger that captures transactions chronologically. According to Cai and Zhu (2016), blockchain is a system built on the Bitcoin protocol. It operates as a peer-to-peer (P2P) electronic secure system that enables payment transfer without the involvement of a financial institution.

Blockchain technology is designed to securely store data records without relying on centralized organizations. This technology works within a framework where the rules for the data are initially set (consensus structure), it goes through a process where the data is recorded in blocks (reconciliation process), and all records are distributed across various locations (distributed ledger). Data is continuously recorded in a sequential manner and contains information from previous data. Each node in the distributed network communicates with every other node (see Figure 3). Removing a node in the record chain does not prevent the system's operation (Usta & Doğantekin, 2017).

Figure 3

Blockchain Network Structure



Source: Usta & Doğantekin (2017)

Iansiti and Lakhani (2017) highlight five principles underlying blockchain technology: distributed database, peer-to-peer communication, pseudonymous transparency, irreversibility of records, and computational logic. The main principle of a distributed database is that all participants in the blockchain can view the entire database and its historical data and verify entries. The second principle, peer-to-peer transmission, refers to direct communication between peers in the network, not through a single central node. Nodes communicate and pass the information they store to other nodes. The third principle, pseudonymous transparency, ensures that users on the blockchain network can remain anonymous if they wish. Each node and user in the network has a specific and defined blockchain address used to conduct transactions. Another fundamental principle, “irreversibility of records,” states that data records in the network are linked in a sequential chain and cannot be changed. Data stored in the database is immutable. The last principle, “computational logic,” refers to the capacity to schedule transactions within

the blockchain network. According to this principle, rules, and algorithms are determined to initiate transactions between nodes in the network automatically.

According to Gupta (2018), the critical characteristics of a blockchain network are “consensus, proof, immutability, and finality.” According to his statement, for a transaction to be considered valid within the network, all participants must agree on its validity. At the same time, ownership of the asset within the network and change of ownership over time serve as evidence, and players need to be aware of these issues. Immutability means that participants cannot change the data. However, if there is an incorrect operation, both operations remain visible on the network and remain on the network even after the problem is fixed. The accuracy feature is directly linked to the shared ledger being the only authoritative source of information.

As a leading technology company, IBM has proposed “smart contracts” as a separate component from distributed ledger technology and immutable data. A smart contract is a digital agreement or predefined rules stored on the blockchain and executed automatically as an integral part of a transaction (Gupta, 2018). These contracts simplify legal transactions, facilitate legal document registration, and enable the transfer of ownership (Cuccuru, 2017). Computer protocols verify smart contract terms, execute them, and enforce them when met (Swan, 2015). Smart contracts increase the superiority of the blockchain platform by automating transactions and eliminating security issues introduced by intermediaries (Orcutt, 2018).

Blockchain technology differs from traditional information systems in that it is decentralized, has strong security measures, is auditable, and has intelligent processing capabilities (Sabeti et al., 2019). Blockchain's information processing framework is depicted in Figure 4, which shows these features.

Figure 4

Process of Blockchain Data and Transactions



Source: Saberi et al. (2019)

A comprehensive definition of blockchain technology was devised by Özsoy (2022). Blockchain is defined as a system that possesses the following characteristics in this definition.

- It is a distributed ledger that is decentralized. The data is dispersed throughout the network and is accessible to all network users.
- It is impossible for a single individual or organization to regulate blockchain networks.
- Transactions are conducted digitally between peers, eliminating the necessity for a central authority or intermediary.
- The data record structure of blockchain networks is sequential. Traces of the prior block are present in each block. Any modifications to the network are promptly communicated to all participants. The entire transaction history is accessible.
- It is impossible to delete transactions that have been executed. It is secure and transparent.
- The security level of the network increases as the number of copied data records increases because of the increase in the number of users on the network.
- The network allows users to maintain their anonymity. Each is allocated a distinctive code. This offers security that prioritizes privacy.
- Consensus serves as its foundation.

- It enables the automatic execution of transactions by utilizing smart contracts.

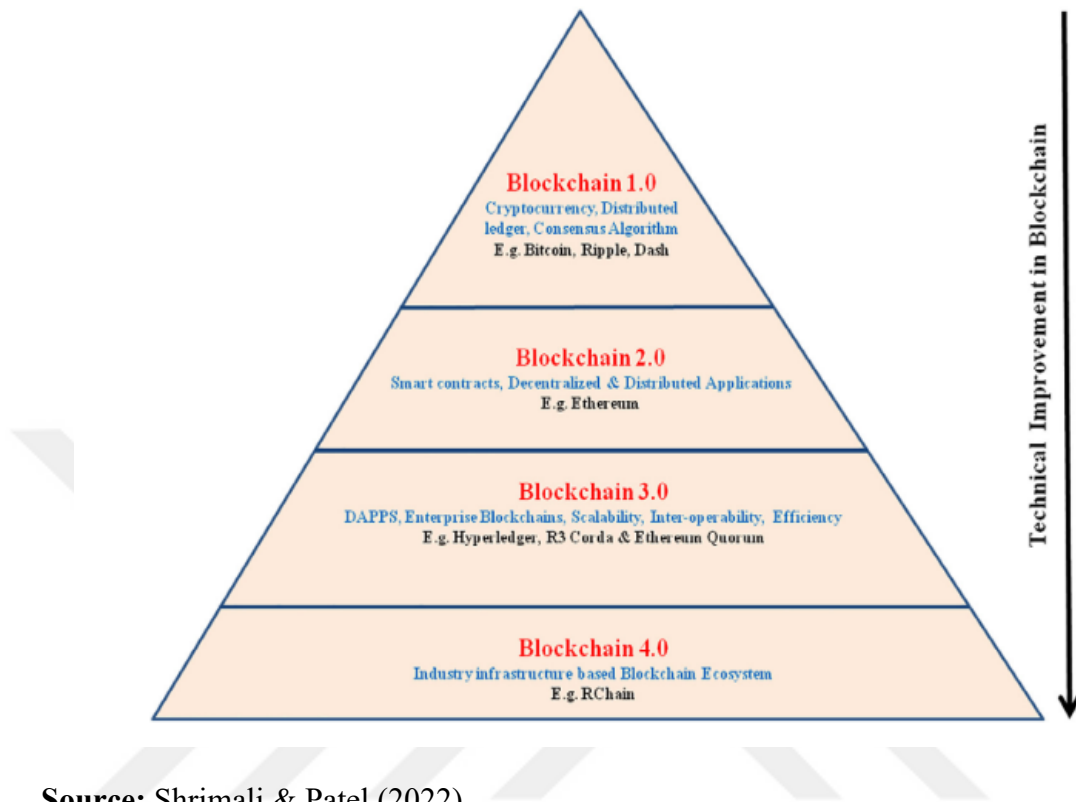
1.1.2. The Evolution of Blockchain

Blockchain is a dynamic and ever-changing technology. Blockchain activities can be categorized into three groups based on their progression: Blockchain 1.0 for digital currency, Blockchain 2.0 for digital finance, and Blockchain 3.0 for digital society. "Blockchain 1.0 refers to the use of technology in digital payment systems and cryptocurrencies." Blockchain 2.0 implements smart contracts to facilitate intricate transactions, including equities, bonds, loans, mortgages, and titles. According to Swan (2015), Blockchain 3.0 can be applied in banking and various sectors such as government, healthcare, science, arts, and culture. This categorization also adheres to the various phases of Blockchain development. Blockchain 1.0, which reached its full development stage in 2008, was succeeded by Blockchain 2.0 and 3.0, which debuted simultaneously in 2015 (Zhao et al., 2016).

Shrimali and Patel (2022) assert that the evolution of blockchain technology has progressed exponentially from its early stages (Blockchain 1.0) to the current phase (Blockchain 4.0). Blockchain 4.0 represents a significant advancement that addresses many of its predecessors' limitations. This phase leverages a distributed environment but encounters challenges like scalability and limited transactions per second. Efforts are focused on enhancing scalability and throughput and reducing latency. For instance, RChain is an illustrative example of advancements in Blockchain 4.0. Following Figure 5 presents the development stages of Blockchain technologies.

Figure 5

Evolution of Blockchain Technology



Source: Shrimali & Patel (2022)

Examining the historical context of the past ten years, bitcoin, initially experimented with as digital money, has evolved into a widespread method of conducting financial transactions for countless individuals. Subsequently, the fundamental technology that facilitates the utilization of Bitcoin was extracted from this money and began to be employed for inter-institutional collaboration in many industries known as Blockchain. Over time, integrating "smart contracts" into the Blockchain system has led to a significant increase in the market value of Blockchain networks and smart contract platforms, surpassing millions and expanding their market potential. The next significant advancement in the system is focused on developing a Blockchain network that can expand its capacity. Not all computers on the network handle every transaction. A network that comprehends which computers are necessary to finish a transaction quickly and efficiently would enhance the speed of processes (Gupta, 2018).

1.1.3. The Types of Blockchain Networks

Blockchain networks can be categorized into two primary types: open (public) and private networks. The key difference lies in whether access to the network requires prior permission. Additionally, these networks can be further classified based on their consensus mechanisms, as explained by Usta and Doğantekin (2017).

Open blockchain networks, also known as public networks, are accessible to anyone without restrictions. These networks can be divided into fully permissionless and partially permissionless types. In fully permissionless networks, such as Bitcoin, anyone can join and participate in the consensus process. These networks aim to increase the user base, thereby amplifying data chain duplication and strengthening network security. Partially permissionless networks, while allowing unrestricted access to view data, require participants to meet certain criteria to actively engage in consensus mechanisms.

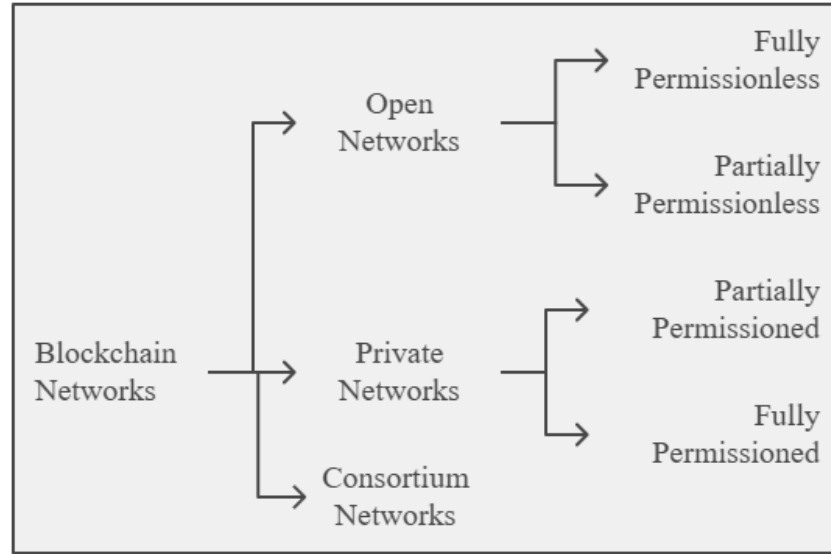
Private blockchain networks, in contrast, operate under strict access controls, granting participation only to authorized users. These networks are widely used by corporations and government institutions due to their enhanced security measures. Based on their consensus structures, private networks can be classified as either partially permissioned or fully permissioned. In partially permissioned networks, authorized users can participate in consensus without additional clearance, facilitating selective data sharing and stakeholder involvement. Fully permissioned networks impose stricter controls, restricting both access and participation to a limited group of users, thereby ensuring robust security through multiple protective layers.

An alternative classification proposed by IBM (n.d.) introduces four types of blockchain networks: public, private, permissioned, and consortium. While public, private, and permissioned networks align closely with the earlier classifications, consortium blockchains represent a distinct approach. In consortium networks, multiple organizations share responsibility for managing the system, determining access rights, and overseeing operations. These networks are particularly suited for collaborative business environments, where controlled access and shared governance are essential.

These classifications highlight the adaptability of blockchain networks in addressing varying levels of openness, security, and operational requirements, catering to diverse organizational needs.

Figure 6

Types of Blockchain



Source: Created by Author

1.1.4. Main Characteristics of Blockchain

Blokzincirin ana özellikleri arasında merkeziyetsiz karar alma, dağıtık işlem yapma, güvenilirlik, eşler arası veri iletimi, verilerin değiştirilemezliği, otomatiklik, hız, düşük işlem ücretleri, takma isimle şeffaflık ve geri döndürülemezlik bulunmaktadır. Ana özellikler aşağıda sırasıyla açıklanmaktadır.

1.1.4.1. Decentralization

Blockchain technology offers significant advantages in terms of decentralization, both for data storage and decision-making and management processes. Decentralization refers to a situation where there is no single control point and power is distributed across a peer-to-peer network (Treiblmaier, 2018). This structure eliminates the need for a central authority to validate transactions and reduces transaction costs by removing intermediaries. While decentralization can pose a threat to existing players in strategic positions within current supply chains and value networks, it also fosters the development of more effective and efficient organizational structures through new management paradigms (Treiblmaier, 2018; Treiblmaier, 2019).

The decentralization of blockchain technology is enabled by innovative consensus protocols. These protocols ensure that the processes of compiling transactions and

creating new blocks adhere to strict rules, preventing any single peer from gaining an unfair advantage. In a blockchain system, all nodes have equal status, and each node records and stores the data blocks generated, thereby enhancing the resilience of the database (Wu & Tran, 2018). Compared to centralized ledgers, blockchain-based data systems offer significant advantages, including fault tolerance; the failure of a single component does not paralyze the entire system (Cai et al., 2023). Decentralized databases are less prone to damage, harder to alter, and do not lead to information asymmetry. These features enable the verification of transactions without intermediaries, reducing the complexity and uncertainty of transaction processes (Wu & Tran, 2018).

Consensus mechanisms are integral to achieving decentralization. They are designed to ensure agreement among network participants on the correct state of data within the system. Consensus mechanisms, such as Proof of Work (PoW), Practical Byzantine Fault Tolerance (PBFT), Proof of Stake (PoS), Proof of Capacity, Proof of Burn (PoB), and Proof of Elapsed Time (PoET), ensure that data on the ledger is consistent across all nodes and protect against data manipulation by malicious actors (Belotti et al., 2019; Yadav et al., 2020). By eliminating the need for a central authority, these mechanisms enhance the fairness and efficiency of transactions and improve response times (Cai et al., 2023).

In summary, the decentralization of blockchain technology, supported by robust consensus mechanisms, provides enhanced security, fault tolerance, and efficiency while reducing the need for centralized control.

1.1.4.2. Distributed Ledger Technology (DLT)

Distributed Ledger Technology (DLT) encompasses a broad range of technologies that involve the distribution of data across multiple locations, countries, or institutions. Unlike traditional databases, where data is centralized and typically managed by a single authority, distributed ledgers operate across a network of nodes, each maintaining a copy of the ledger. This technology allows for the recording of transactions in a sequential manner, although it does not rely on blocks like blockchain does. Records are added to the ledger only when a consensus or quorum is reached among participants, ensuring that all entries are validated (Government Office for Science, 2016).

The key characteristic of a distributed ledger is its shared nature. The ledger is accessible to all participants within the network, which helps eliminate redundancy and the need for

multiple copies of the same data. This shared access facilitates transparency and reduces the risk of duplication of effort that is often seen in traditional business networks (IBM, n.d.).

DLT can be categorized based on its accessibility and control mechanisms (Treiblmeir, 2018):

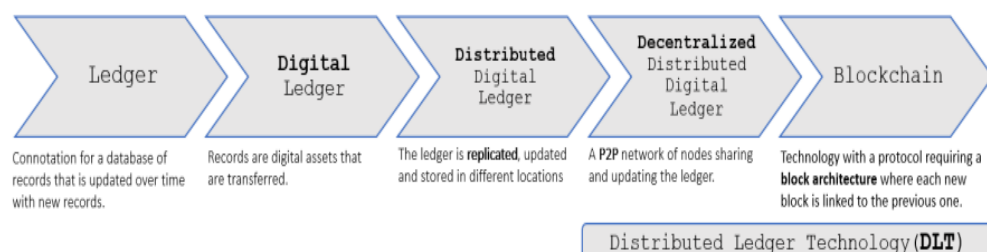
- *Permissioned and Private Ledgers:* These are controlled by a specific group of owners or users, such as in a clearing or settlement network. Access is restricted, and only authorized parties can participate.
- *Permissioned and Public Ledgers:* These are available to the public but maintained with integrity by trusted entities. Examples include global financial transaction systems where access is open but controlled
- *Permissionless and Public Ledgers:* These are open to anyone and maintained through a trustless consensus mechanism. An example is blockchain-based cryptocurrencies, where consensus is achieved without relying on a central authority (Treiblmeir, 2018).

In a distributed ledger system, every participant can access the entire database and its complete transaction history. No single party has control over the data; instead, every participant can directly verify the records of their transaction partners, eliminating the need for intermediaries (Iansiti & Lakhani, 2017).

Figure 7, illustrates the evolution of DLT and its various implementations over time.

Figure 7

DLT Evolution



Source: Belotti et al. (2019)

1.1.4.3. Transparency

Blockchain technology ensures transparency by making transactions visible and verifiable to all participants within the network. Each transaction and its associated value are accessible to anyone with permission to view the system, thereby establishing a fundamental level of transparency (Kamble et al., 2021; Iansiti & Lakhani, 2017). This feature is particularly crucial when tracking products throughout the supply chain (Kshetri, 2018).

The blockchain system operates using trusted mathematical algorithms that regulate transaction behavior, eliminating the need for mutual trust between nodes. The rules governing the system are publicly available and transparent. While each node's private information is encrypted, other data remain open to everyone. Users can access blockchain data by querying through the block header's hash value, and the information is redundantly stored across multiple nodes. To update information, multiple nodes must authenticate the change, preventing any single node from misleading others and ensuring high transparency throughout the system (Wu & Tran, 2018).

Transparency in blockchain systems also distinguishes between permissioned and permissionless blockchains. Permissioned blockchains, operated by a consortium of members, restrict access to data, limiting visibility to a specific group of stakeholders. In contrast, permissionless blockchains, such as Bitcoin, allow anyone to review blocks, providing broader transparency (Treiblmeir, 2019).

Blockchain technology also offers transparency combined with pseudonymity, where users can either remain anonymous or provide proof of their identity (Wang et al., 2019). This combination enhances trust in financial transactions while also raising concerns about the protection of personal data.

In summary, the transparency feature of blockchain technology enhances data accuracy and reliability in the processes such as SCM, while also accommodating varying privacy needs across different use cases (Queiroz & Fosso Wamba, 2019; Shahzad et al., 2024)

1.1.4.4. Immutability

Immutability is a fundamental feature of blockchain technology that shifts the paradigm from the "Internet of Information" to the "Internet of Value." Unlike digital information, which can be copied and shared without loss of accuracy, blockchain enables the secure

transfer of value between peers while preventing issues such as double spending (Treiblmeir, 2019). This characteristic is especially valuable for tracking transactions along the supply chain, where maintaining consistent and tamper-proof records is crucial.

Blockchain achieves immutability through a system of hash functions that encrypt data in a chain-like manner. Each block in the chain contains a hash of the previous block, making it nearly impossible to alter data without affecting all subsequent blocks. Once a transaction is recorded on the blockchain, it cannot be modified by any participant. If an error is discovered, a new transaction must be added to correct it, and both the original and the corrected transactions will remain visible on the ledger (IBM, n.d.).

This feature is also known as the irreversibility of records. Once a transaction is entered into the blockchain and accounts are updated, the records become immutable. They are linked to every preceding transaction, forming a chain. Various computational algorithms and approaches ensure that these records are permanent, chronologically ordered, and accessible to all participants on the network (Iansiti & Lakhani, 2017).

Despite its advantages, immutability has limitations. While it guarantees data integrity and security, it complicates modifications or deletions of records, particularly when updates are necessary for legal or other reasons. Additionally, the pseudonymous nature of public blockchains, rather than true anonymity, may raise privacy concerns as it does not fully prevent the identification of participants (Treiblmeir, 2019).

In summary, the immutability of blockchain technology ensures that once data is recorded, it remains unchanged, enhancing the reliability of the system while limiting flexibility and raising potential privacy issues.

1.1.4.5. Traceability

Traceability has emerged as a critical success factor in modern supply chains, enabling the tracking and monitoring of all transactions and information exchanged. This capability allows for the identification of all collaborating suppliers and provides transparency regarding the origins of products, catering to consumers who increasingly seek detailed information about their purchases (Morkunas et al., 2019).

Blockchain technology enhances traceability by ensuring that records added to the ledger are permanently stored. Each transaction is linked with detailed trader information, enabling the complete transfer path of a product to be recorded and traced

comprehensively. This facilitates effective supervision and verification of transactions (Wu & Tran, 2018). For example, in the Bitcoin blockchain, data manipulation would require controlling more than 51% of the network's computing power, which is economically prohibitive, thereby providing high security against tampering (Wu & Tran, 2018).

Blockchain achieves data tamper protection, security, and credibility through asymmetric cryptographic principles and consensus algorithms. These mechanisms defend against external attacks and ensure that blockchain data remains immutable and resistant to forgery (Wu & Tran, 2018).

In practical terms, blockchain's traceability is exemplified by projects like IBM's TradeLens and Food Trust, which utilize the technology to combat counterfeiting in pharmaceuticals, diamonds, and luxury goods. By timestamping, recording, and disseminating data throughout the production, transportation, and sales stages, blockchain technology addresses issues of authenticity and traceability effectively (Cai et al., 2023).

In the context of blockchain-supported traceability, authorized individuals can monitor specific products along with their tracking history, content, and batch information (Shahzad et al., 2024). This capability significantly enhances transparency and accountability in SCM.

1.1.4.6. Programmability, Automation and Smart Contracts

Blockchain programmability is closely associated with automation and smart contracts. These features enable the automatic execution of transactions and enforcement of contract terms through code, reducing the need for traditional intermediaries and enhancing efficiency. Smart contracts are self-executing computer programs that perform predefined actions when specific conditions are met. They strengthen the ability to manage variables and assets on the blockchain (Treiblmeir, 2019; Wu & Tran, 2018; Wang et al., 2019; IBM, n.d.; Belotti et al., 2019).

Smart contracts are integral to blockchain programmability. They facilitate automated execution of transactions, such as corporate bond transfers or travel insurance payments, thus eliminating the need for intermediaries (IBM, n.d.). Embedded within the blockchain, these contracts are triggered alongside transactions, enabling ledger state modifications and asset exchanges (Belotti et al., 2019). Additionally, blockchains can be

programmed to automatically initiate actions between nodes, enhancing contract execution efficiency and ensuring compliance without extensive oversight (Wu & Tran, 2018; Wang et al., 2019).

In summary, blockchain programmability through smart contracts promotes efficient, automated transactions while addressing limitations of traditional contractual agreements.

1.1.4.7. Anonymity and Privacy

Blockchain technology offers a privacy-preserving framework that significantly enhances information security. It utilizes cryptographic techniques, such as private keys, to ensure data privacy and anonymity. One of the key methods employed is ring signatures, which enable the verification of signers while maintaining their anonymity. This approach ensures that a signer's private key is linked to a unique set of public keys without disclosing the specific identity of the signer (Nakamoto, 2008). Consequently, blockchain technology secures data while safeguarding stakeholder privacy.

In blockchain systems, anonymity is preserved as data exchanges between nodes adhere to a fixed algorithm, eliminating the need for parties to disclose their identities. Trust is established through procedural rules embedded within the blockchain rather than through personal identification (Wu & Tran, 2018).

In addition to privacy, blockchain technology is designed with robust security features. Various computational algorithms and cryptographic approaches ensure that records on the blockchain are permanent, chronologically ordered, and accessible to all participants in the network. The distributed and encrypted nature of blockchains makes them resilient to hacking attempts, further enhancing their security (Wang et al., 2019).

In summary, blockchain technology effectively balances privacy and security by employing cryptographic methods to ensure anonymity while securing data against unauthorized access and tampering.

1.1.4.8. Disintermediation and P2P Transmission

Disintermediation and peer-to-peer (P2P) transmission are fundamental characteristics of blockchain technology that intersect with its decentralization and distributed network architecture. In a blockchain network, communication takes place directly between peers rather than through a central node. Each node in the network not only stores but also

forwards information to all other nodes, ensuring that data is consistently and transparently shared across the network (Iansiti & Lakhani, 2017).

This direct communication mechanism reduces reliance on third parties, effectively eliminating intermediaries that are typically required in traditional systems. By removing these intermediaries, blockchain networks decrease transaction costs and streamline processes (Wang et al., 2019).

The decentralized nature of blockchain is further enhanced by its distributed network technology, where each node maintains an identical copy of the ledger. This structure supports the disintermediation of transactions and services by enabling direct interactions and data exchanges between network participants.

Additionally, smart contracts play a crucial role in this context. They are automated protocols embedded within the blockchain that execute predefined conditions without requiring intermediaries. Smart contracts leverage the decentralized and P2P nature of blockchains to ensure that contractual terms are enforced automatically, thereby further facilitating direct and trustless transactions among peers (Wu & Tran, 2018).

In summary, the disintermediation and P2P transmission capabilities of blockchain technology are integral to its decentralized and distributed architecture. These features enhance efficiency, reduce costs, and support the automated execution of agreements through smart contracts, reflecting the transformative potential of blockchain systems.

1.2. Blockchain Enabled Supply Chain Management

1.2.1. Blockchain Technology for Supply Chains

Blockchain technology in the context of supply chains can be defined as decentralized databases or ledgers shared among networks and supply chain participants (Kouhizadeh & Sarkis, 2018).

SCM involves the coordination and management of a complex network of activities aimed at delivering products to the end-user or customer. This process includes key functions such as sourcing raw materials and components, manufacturing and assembling products, warehousing, order entry and tracking, distribution, and finally, delivery to the customer. In this process, various actors, including external suppliers, external distributors, and customers, participate and may simultaneously be members of multiple

supply chains. Therefore, SCM and coordination face complexities arising from different geographical boundaries, multiple time zones, various government regulations, customer expectations, and competitive environments (Hervani et al., 2005).

Globalization has increased competition and outsourcing, leading to an increase in the number of actors in the supply chain. This situation has made supply chains more complex and increased uncertainty within the chain (Manuj & Mentzer, 2008). In a business environment characterized by uncertainty, risks such as asymmetric information problems and fraud are among the risks that supply chain actors may encounter (Baird & Thomas, 1990). The primary goals of SCM are to reduce risks arising from these uncertainties and to deliver products under the right conditions, at the right time, and at the lowest cost (Flint, 2004). SCM aims to meet consumer demand by utilizing resources such as labor, inventory, and distribution capacity more efficiently and integrating business processes with dynamic market demands (Parung, 2019).

Blockchain technology has the potential to create significant changes in SCM. Blockchain emerges as a significant technological tool in SCM for reducing costs, minimizing risks, and increasing efficiency. In traditional supply chain processes, the lack of an audit or centralized mechanism to ensure the rules' compliance among supply chain actors leads to transparency and traceability issues (Parung, 2019). Blockchain technology, with its distributed ledger structure, sequential data recording structure, and traceability features, overcomes the major obstacle in the supply chain, which is the trust issue. As the data in this network is instantly accessible by all participants, transactions can be conducted without the need for intermediaries, and changes in the data can be instantly tracked. These features make the system transparent and secure. Additionally, using smart contracts that execute transactions without requiring a central authority increases the reliability of transactions (Constantinides et al., 2018). The use of blockchain provides higher flexibility in the supply chain, which provides a competitive advantage to the supply chain in delivering products and services on time and at an appropriate cost.

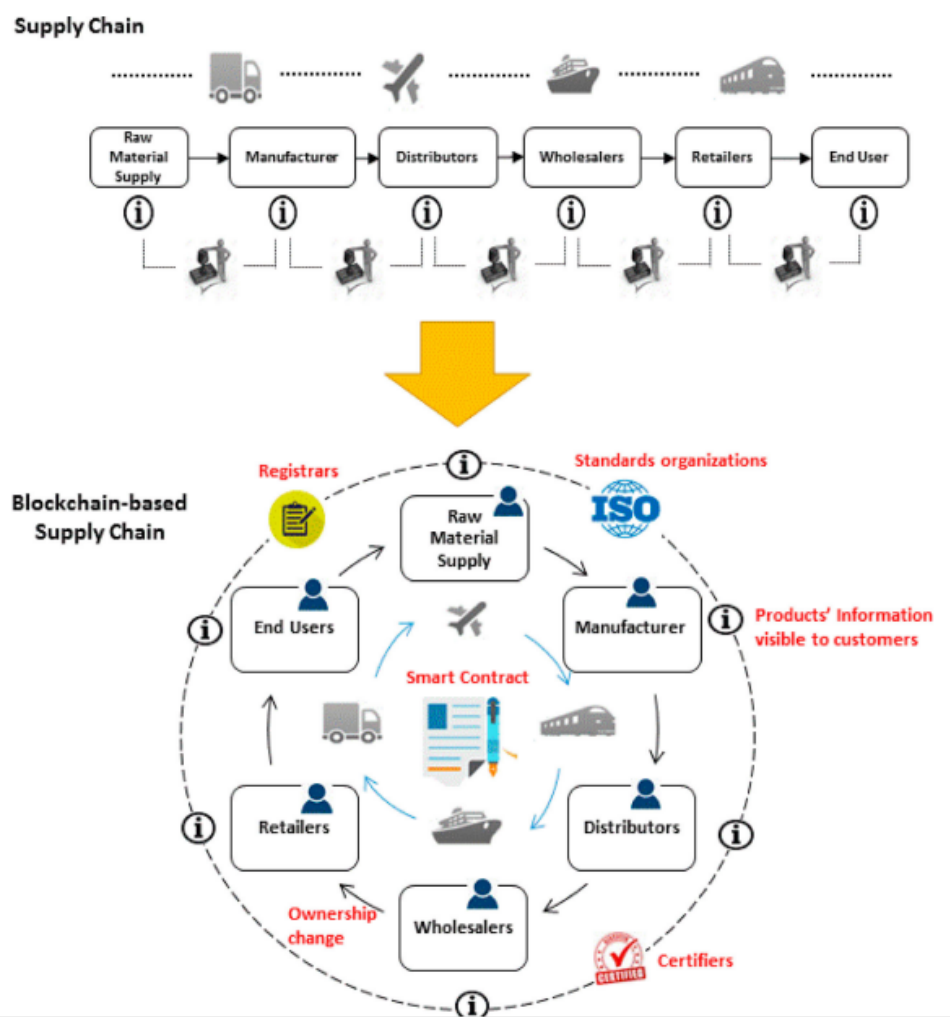
The following Figure 8 provides a general graphic of the transformation from a traditional supply chain to a blockchain-based supply chain. In blockchain-based supply chains, four main entities play roles:

- i. registry companies that provide unique identities to actors in the network,

- ii. standard organizations that define standards schemes for sustainable supply chains or blockchain policies and technological requirements, such as Fairtrade,
- iii. certification providers that provide certification to actors for participation in the supply chain network, and
- iv. actors including producers, retailers, and customers who must be approved by a registered auditor or approver to ensure system trust (Sabeti et al., 2019).

Figure 8

Supply Chain Transformation



Source: Sabeti et al. (2019)

Compared to traditional supply chains, blockchain-enabled SCM facilitates tracking purchase volumes independently from different sources. A centralized digital ledger allows for better negotiations with suppliers and achieving quantity discounts. Blockchain technology helps in accurate demand forecasts, efficient resource management, and

reducing inventory costs. Additionally, it enhances visibility and transparency in the supply chain through robust record-keeping functions, improving monitoring systems (Kamble et al., 2019).

Kshetri (2018) discusses case studies of blockchain projects developed for different purposes, explaining how blockchain contributes to supply chain goals through various mechanisms. The following Table 1 shows how blockchain can contribute to fundamental SCM goals such as cost, quality, speed, reliability, risk reduction, sustainability, and flexibility.

Table 1

The Functions of Blockchain in Accomplishing Different Strategic Supply Chain Goals

Supply chain performance dimension	Blockchain's roles
<i>Cost</i>	Even for minor transactions, it makes financial sense to establish a blockchain code.
	A crisis involving faulty goods, like tainted food: locating the cause with ease and taking strategic removal of impacted products rather than a complete product line recall
	Provide precisely the appropriate number of resources to carry out shipping and other tasks.
	Removal of paper records quickly.
<i>Speed</i>	Reduction of regulatory compliance expenses is possible.
	Partners in the supply chain are prohibited from using subpar and fake substances.
	Can offer information that can be utilized to evaluate representative, meaningful, and practical indicators of quality.
<i>Dependability</i>	Partners in the supply chain should anticipate a high degree of measurement reliability for a variety of metrics, including weights and quality.
	Applying pressure on supply chain participants to take greater accountability and responsibility for their activities.
<i>Risk Reduction</i>	Utilizing blockchain technology to enhance reliability through digital certification.
	The "super audit trail" of blockchain technology can effectively tackle the issues related to self-reported data provided by supply chain partners. Addressing the comprehensive origins of risk.
	Transactions in specific touchpoints can only be conducted by parties that have been mutually accepted in the network.
<i>Sustainability</i>	Validating sustainability: it is feasible to enhance the measurability and significance of indicators pertaining to sustainability.
<i>Flexibility</i>	Network effects can occur even with a few people using a blockchain solution, resulting in a significant impact. The efficacy of this solution is amplified by the network effect.

Source: Kshetri (2018)

Blockchain's role in SCM can also be addressed for different stages of the supply chain: procurement, manufacturing, and distribution. Firstly, regarding procurement, blockchain increases digital trust by providing transparency in the purchasing process of the supply chain. Through smart contracts, it integrates product delivery, invoice creation, and payment processes, accelerating transaction processes between businesses and facilitating financial operations. Secondly, the manufacturing stage involves a process where a lot of data is produced. At this point, blockchain can significantly automate the production cycle by automating verification processes and verifying conditions through smart contracts. Thirdly, looking at the distribution side, the benefits of increased transparency and better tracking capabilities in the supply chain are evident in delivery processes. As supply chains expand, the risk of inconsistencies in information flow and product quality increases, directly affecting customer satisfaction. Organizations do not want to experience loss in this area in a highly competitive environment. Blockchain technology, integrated with systems like GPS, can collect data through distribution vehicles. The immutable nature of blockchain protects data against fraud and allows it to be used for analytical purposes, increasing the operational efficiency of the supply chain (Kamble et al., 2019).

Finally, blockchain also plays an important role in supply chain financing. A study by Lakhani and other researchers shows that blockchain applications offer significant advantages in supply chain financing. It is stated that this technology can improve supply chain performance by providing 74% more efficient use in logistics and 75% higher productivity in digital documentation. Kabir et al. (2021) emphasize that the primary purpose of blockchain in supply chain financing is to increase accountability and clarity through record-keeping functions. Blockchain can help integrate roles in the supply chain by serving as a single data source, reducing product transportation costs with its capacity to make reliable demand forecasts, and efficiently managing capital. Additionally, it provides transparent visibility to financing companies, improving investment decisions and reducing risks at lower costs than traditional methods.

Following Table 2 provides a concise overview of various use cases of blockchain technology in SCM .

Table 2*Examples of Blockchain Integration in Supply Chain Operations*

Use Case	Explanation	Source
Maersk	Maersk uses blockchain technology in international shipping to track the location, temperature, and other conditions of containers, significantly reducing paperwork and labor requirements. Additionally, the Tradelens platform facilitates collaboration among over 150 exporters, importers, shipping companies, and customs authorities.	Özsoy (2022); Groenfeldt (2017); Kshetri (2018); Gupta (2018);
Provenance	The Provenance project, applied in the fishing industry in Indonesia, uses blockchain and smart labeling technology to ensure traceability of fish, helping to prevent overfishing, fraud, and human rights violations.	Özsoy (2022); Kshetri (2018)
Modum	Developed by the University of Zurich, Modum uses blockchain and smart contracts to ensure the safe transport of pharmaceuticals that require specific temperature, humidity, and light conditions.	Özsoy (2022); Kshetri (2018); Allen (2017)
IBM Blockchain World Wire	IBM's Blockchain World Wire system facilitates real-time cross-border payments using digital assets as a bridge between two fiat currencies, recording all transaction details on the blockchain. This leads to faster and lower-cost international capital transactions.	Özsoy (2022); Gupta (2018);
Intel	Intel's Sawtooth Lake-based demo project for the seafood supply chain tracks the fish journey from capture to restaurant, using IoT telemetry and temperature data recorded on the blockchain to ensure food storage compliance.	Kshetri (2018)

Source: Created by author.

1.2.2. Potential Benefits and Challenges of Blockchain in SCM

The potential benefits of blockchain technology in SCM are evaluated on various dimensions. Firstly, blockchain applications enable the verification of every action occurring in supply chain processes, including who, where, when, and how long it took. This allows for the objective measurement of SCM process performance. Since data in blockchain cannot be altered or deleted, it builds trust among suppliers and reduces costs, increasing efficiency (Koetsier, 2017).

Secondly, blockchain technology accelerates interactions between the supplier and buyer in SCM processes by eliminating intermediary auditors, reducing costs. All suppliers can monitor the shipment and delivery statuses in real-time and control their balances. This ensures more transparent and efficient management of operations (Koetsier, 2017).

Thirdly, blockchain technology provides reliable information on product quality in SCM processes. Particularly in the trade of perishable goods, the data provided about travel times and conditions of products make it possible to monitor and verify product quality. This may increase customers' willingness to prefer brands using blockchain technology (Kshetri, 2018).

Casey and Wong (2017) highlight the importance of blockchain technology for the food supply chain by providing the example of the E.coli bacteria outbreak that affected 55 people at Chipotle Mexican Grill restaurants. The affected company lost reputation, and its stock prices and sales plummeted suddenly. The complex and non-transparent traceability of the supply chain process played a role in this situation. Blockchain infrastructures provide significant benefits to all parties in the supply chain process, including warehouses and stores, in terms of speed and transaction cost. Stores that have information about the arrival time of shipments can be ready to receive the shipment (Groenfeldt, 2017).

On the other hand, there are some challenges that blockchain technology faces in supply chain applications. The first challenge encountered during the implementation phase arises from the complex structure of the global supply chain. The global supply chain involves various regulations, including maritime laws, commercial laws, and multiple jurisdictions along shipping routes that different parties must comply with. The necessity of operating blockchain-based solutions in conjunction with established traditional practices and institutions makes the situation complex (Casey & Wong, 2017). Related to this, the second challenge is the difficulty of bringing all actors in the global supply chain together on the blockchain. Another challenge is the security and transparency issues due to limited access in corporate-designed blockchains. Corporate blockchains with limited access may become targets for hackers due to the small number of copies of data nodes. Another challenge is that blockchain technologies require advanced technological development. Therefore, supply chain members in countries that have not yet completed their advanced technological development may not be able to participate in the network, limiting the benefits of blockchain (Kshetri, 2018).

The summary of the benefits created and the challenges faced by SCM with blockchain are presented in Table 3.

Table 3*Benefits and Challenges of Blockchain in Supply Chain Management*

Benefits	Challenges
Improves supply chain visibility by reducing the need for double-checking and allowing the automation of data analysis.	Trust and related requirements: Many organizations are uncertain about the technical details of blockchain.
Ensures secure information sharing and builds trust by providing one single data pool and system accessible to all stakeholders.	The technology is still in its infancy.
Enables operational improvements by helping organizations better monitor and evaluate their performance through increased data volume and accuracy while providing opportunities to identify problems before they occur.	Complex technology concepts and difficulty in understanding.
Provides extended visibility and traceability to stakeholders	Issues that can be solved with traditional databases and information systems.
Offers simplified, digitalized, and optimized SCM operations.	Cultural, procedural governance, and collaboration issues.
	Data entry and information sharing issues.
	Technological and network interoperability issues.

Source: Wang et al. (2019)

In conclusion, blockchain technology holds significant potential in SCM, but global regulatory and technical challenges must be considered. For broader adoption of this technology, these challenges need to be addressed.

CHAPTER 2. BLOCKCHAIN TECHNOLOGY ADOPTION IN SUPPLY CHAIN MANAGEMENT

2.1. Theoretical Foundation

The adoption behavior of blockchain technology has frequently been investigated using theories and models such as the TAM, the UTAUT (Queiroz & Fosso Wamba, 2019; Queiroz et al., 2020; Wong et al., 2020), and the TOE framework (Clohessy et al., 2019; Clohessy & Acton, 2019; Orji et al., 2020; Vergouwen et al., 2020; Wong et al., 2020; Choi et al., 2020). A few studies have also utilized the DOI (Agi & Jha, 2022).

TAM considers two distinct variables, perceived usefulness and perceived ease of use, to evaluate attitudes and behavioral intentions toward technology adoption, taking individual differences into account. UTAUT, as an extended version of TAM, considers four key constructs—performance expectancy, effort expectancy, social influence, and facilitating conditions—along with moderators such as gender, age, experience, and voluntariness of use to explain individual adoption (Venkatesh et al., 2003). Unlike TAM and UTAUT, which examine individual-level adoption intentions, the TOE framework investigates technological adoption by considering organizational-level factors. TOE allows for the comprehensive evaluation of organizational adoption intentions within technological, organizational, and environmental contexts and provides insights into an organization's internal and external dynamics (Tornatzky & Fleischer, 1990). Unlike UTAUT and TOE, DOI takes into account the nature of the innovation itself.

Since blockchain technology is a relatively new technology, information technology acceptance models are an appropriate approach to understanding adoption behaviors in the context of the supply chain. In this section, the theoretical foundations of TAM, UTAUT, TOE, and DOI will be addressed sequentially.

2.1.1. Technology Acceptance Model

The TAM was first developed by Davis (1989) to explain users' adoption of new technologies and the critical factors influencing this acceptance. TAM is based on the Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) to predict users' acceptance of technology and identify the reasons for this acceptance. TRA posits that individuals develop intentions based on attitudes and social norms, influencing their

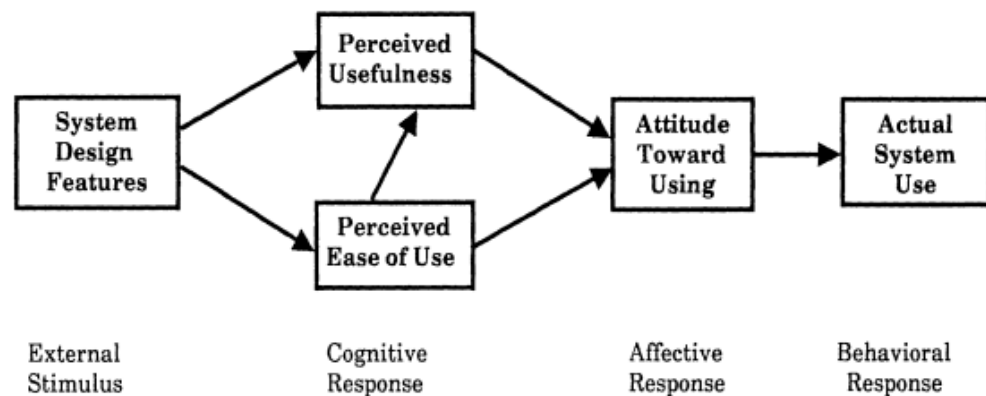
behaviors. TPB emphasizes that individuals' behaviors are influenced not only by their intentions but also by their perceived behavioral control.

The core principle of TAM is that perceived usefulness (PU) and perceived ease of use (PEOU) influence individuals' acceptance of technology. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance their job performance" (Davis, 1989). Perceived ease of use is defined as "the degree to which a person believes that using the technology would be free of effort" (Davis, 1989). Venkatesh and Davis (2000) highlighted that perceived ease of use is a significant factor influencing user acceptance and behavioral intention.

The following Figure 9 illustrates the variables and causal relationships in the Technology Acceptance Model. As depicted, PU and PEOU are the two main variables influencing usage intention, with PEOU having a causal effect on PU. The System Design Feature directly impacts perceived ease of use and usefulness, which indirectly affects attitude through this direct impact.

Figure 9

Technology Acceptance Model



Source: Davis (1989)

Venkatesh and Davis (2000) proposed an extended TAM model (TAM2) by adding social influence processes, job-related factors, output quality, and result demonstrability. In TAM2, these factors, along with perceived ease of use, influence perceived usefulness, affecting usage intention and behavior. Venkatesh and Bala (2008) further developed TAM2 into TAM3 by including additional factors such as individual differences, system characteristics, and facilitating conditions. In TAM3, these new antecedents influence perceived ease of use.

TAM has been widely used to predict and understand user acceptance of technologies in various fields (Musa et al., 2024). While past TAM studies have often considered demographic differences, the impact of personality has generally been neglected. Personality can vary in its relationships with factors such as perceived usefulness and perceived ease of use (Chang & Huang, 2015).

Although TAM is a robust theory for predicting technology acceptance, it has limitations. Specifically, it has been found inadequate in predicting technology acceptance in contexts where socio-organizational and cultural factors, such as healthcare, play a significant role. Additionally, it has been emphasized that cultural and social influences have a significant impact on the adoption and use of smartphones and related technologies in developing economies, and thus TAM should consider these factors.

Therefore, it can be said that the extended versions of TAM provide a more comprehensive and in-depth understanding of the technology adoption process.

2.1.2. Technology-Organization-Environment Context

The TOE framework aims to identify the technological, organizational, and environmental factors influencing the adoption of information technology (IT) innovations in organizations (Tornatzky & Fleischer, 1990). The TOE framework offers flexibility to incorporate different dimensions and theories, as well as the contextual determinants of behavior within each dimension (Shahzad et al., 2024). This flexibility allows the model to be widely applied to various IT innovations, such as the Internet of Things (IoT), cloud computing (CC), and RFID (Chittipaka et al., 2023). Additionally, there is an opportunity to extend the TOE framework to IT adoption studies within SCM. The TOE framework is frequently referenced in studies on the adoption of blockchain technology (Clohessy et al., 2019; Clohessy & Acton, 2019; Orji et al., 2020; Vergouwen et al., 2020).

The technological factors of the TOE framework include aspects such as complexity, relative advantage, privacy, security, and compatibility that may affect existing IT systems or new IT considered for adoption (Clohessy et al., 2019). The technological dimension includes the firm's internal and external technology pools and the perceived benefits, compatibility, complexity, and usage of these technologies (Aslam et al., 2021).

Organizational factors refer to the resources and internal characteristics within an organization. These factors include previous IT experience, innovativeness, top management support, organizational size, information intensity, and organizational readiness (Chittipaka et al., 2023).

Environmental factors encompass external factors that impact an organization's daily business operations. These factors generally include competition, industry dynamics, government interactions, and regulations (Clohessy et al., 2019).

2.1.3. Diffusion of Innovation Theory

Rogers (1995) defines the DOI around four elements: i. Innovation, defined as an idea perceived as new by an individual or organization, ii. Communication channels through which the innovation spreads among members of a system over time, iii. The time aspect of diffusion, and iv. The social system within which the innovation spreads.

According to Rogers (1995), the novelty of the idea causes individuals to be uncertain, and the adoption of a new idea depends on their perception of the innovation. ii. Interpersonal communication plays a role in eliminating these uncertainties and spreading innovations over time. Individuals overcome uncertainties by comparing the innovation with existing ideas and benefiting from peer experiences. iii. The diffusion of innovation takes time. In the early years of innovation, the number of adopters is low, then it increases rapidly and continues to grow at a slower rate, following an S-shaped curve. The diffusion of innovation starts with the group called early adopters, and the point where the diffusion curve becomes self-sustaining is defined as the critical mass.

The critical mass occurs when a sufficient number of individuals have adopted the innovation, making the rate of adoption self-sustainable. After this point, the adoption rate progresses rapidly. Therefore, the point at which critical mass is achieved is significant for innovation promoters and depends on several factors. The first factor is the relative advantage of the innovation compared to existing practices and its compatibility with current values. The second factor is the presence of a technological infrastructure supporting the innovation. The third factor is individual resistance thresholds to adopting the innovation.

Lastly, iv. diffusion occurs among the members of a social system. This system may have norms that encourage or discourage an individual from adopting or rejecting an

innovation. Additionally, the system in which the innovation spreads can have a strong impact on the adoption rate of the new idea (such as a lack of infrastructure in the system).

DOI investigates the adoption rate of new technology by examining how users respond to and accept a new concept. According to the theory, the adoption of an innovation largely depends on five key attributes: relative advantage, compatibility of the technology, complexity of the technology, observability of the innovation, and trialability of the technology (Kumar Bhardwaj et al., 2021).

First, the relative advantage of the innovation refers to the benefits it provides compared to existing technological options. Second, the compatibility of the technology determines how well it aligns with the organization's existing systems and processes. Third, the complexity of the innovation indicates how difficult it is to understand and use the new technology. Fourth, observability relates to how visible the results of the innovation are. Finally, trialability refers to whether the innovation can be tested on a small scale (Rogers, 2002).

However, in the literature on information technology innovations, the trialability and observability factors of the DOI theory are often overlooked. This is because the nature of organizational technology adoption is typically a top-down activity, resulting in limited trialability and observability within the organization (Agi & Jha, 2022).

Some researchers argue that organizational and external environmental factors should also be considered, as the DOI theory focuses only on the characteristics of the innovation. In this context, Agi and Jha (2022) supported this theory with a framework specific to the organization and external environment, examining the factors influencing the adoption of blockchain. The results of the study showed that the most important factors were external pressure and the relative advantage of blockchain. Therefore, while the DOI theory provides an important framework for understanding the innovation adoption process, considering organizational and external environmental factors allows for a more comprehensive understanding of the technology adoption process.

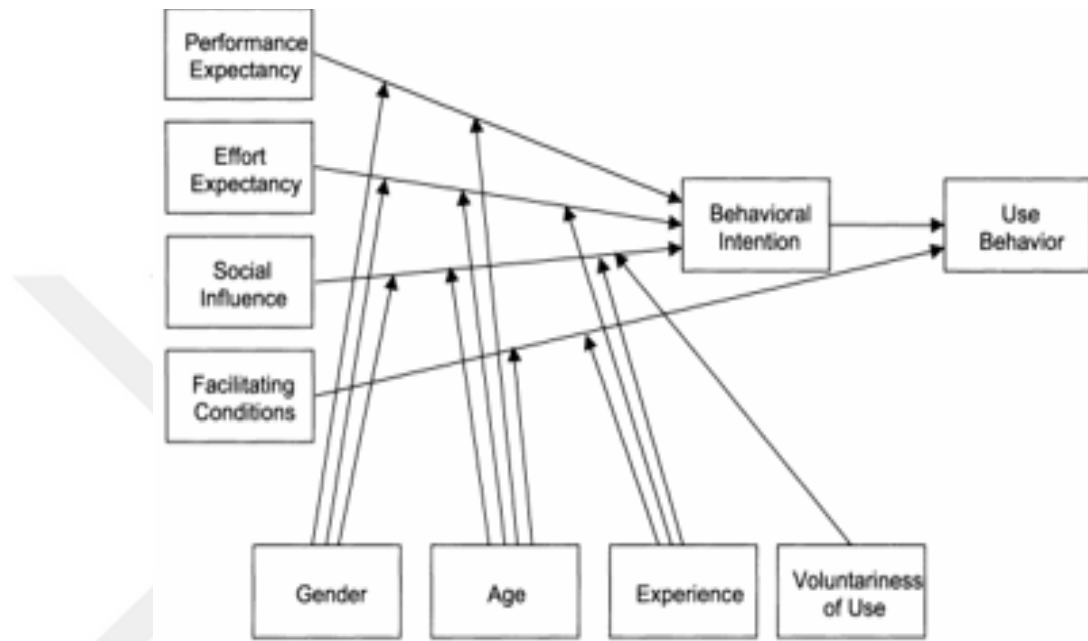
2.1.4. Unified Theory of Acceptance and Use of Technology Model

The UTAUT was proposed as a synthesis of eight models from previous acceptance literature (Venkatesh et al., 2003). The UTAUT model was developed to explain the acceptance and use of information technologies, comprising four key constructs:

performance expectancy, effort expectancy, social influence, and facilitating conditions. Additionally, factors such as gender, age, experience, and voluntariness of use act as moderators within the model (Venkatesh et al., 2003).

Figure 10

UTAUT Model



Source: Venkatesh et al. (2003)

The UTAUT model has found broad application in explaining the acceptance and use of information technologies (Tamilmani et al., 2017; Venkatesh et al., 2016). In the model, performance expectancy is the perceived increase in job performance from using the technology. Effort expectancy is the perceived ease or difficulty of using the technology. Social influence is the perception of the attitude of essential referent groups towards the use of technology. Facilitating conditions are the perceived presence of organizational and technical infrastructures supporting the use of the technology.

In 2012, Venkatesh et al. (2012) proposed the UTAUT2 model by adding three new constructs: hedonic motivation, price value, and habit. Hedonic motivation is the perceived enjoyment derived from using technology. The price value is the perceived value of the technology relative to its cost. Habits are the tendencies of individuals to use technology regularly and automatically. The UTAUT2 model provides a more comprehensive perspective for explaining the adoption of new technologies.

The strength of the UTAUT model in explaining the acceptance and use of information technologies has been supported by various meta-analyses. A meta-analysis by Khechina et al. (2016) covering 74 publications revealed that performance expectancy, effort expectancy, and social influence explain the adoption of IS/IT. In this study, behavioral intention was used as a proxy for system usage, being the most frequently measured dependent variable. These findings support the explanatory power of the UTAUT model. Other meta-analyses by Dwivedi et al. (2019) have also confirmed these constructs as significant determinants of technology adoption.

UTAUT has frequently been used to examine the adoption of blockchain technology in supply chains. A study by Ennajeh & Najjar (2024) found that performance expectancy, social influence, and facilitating conditions influenced adoption intentions. Zhang et al. (2023) extended the model to include factors such as technology readiness, technology affinity, and trust, providing insights into behavioral intentions toward the adoption of blockchain technology in SCM in Pakistan.

2.1.5. Integrated and Relational Theoretical Approach

The adoption process of blockchain technology has a multidimensional structure shaped by the interaction of individual, organizational and environmental factors. In this thesis, an integrated and relational theoretical approach is adopted to examine the blockchain adoption process more comprehensively. In the study, four main theories, TAM, UTAUT, TOE Framework and DOI, are considered in an integrated structure and different dimensions of the blockchain adoption process are analyzed.

It is argued that the blockchain adoption process cannot be explained solely by individual or organizational factors; technological, environmental and contextual factors should also be considered. Accordingly, the perspectives offered by each theory are integrated as follows:

- TAM; Perceived usefulness and perceived ease of use are among the factors that affect individuals' perceptions of technology and adoption intentions.
- UTAUT; It examines the effect of demographic variables (gender, age, experience) by evaluating the factors affecting individual acceptance such as performance expectancy, effort expectancy, social influence and supportive conditions.

- TOE Framework; It explains the adoption process of organizations in technological, organizational and environmental dimensions and explains the interaction of internal and external factors.
- DOI; Evaluates the impact of factors such as relative advantage, compatibility, complexity, observability and trialability on the adoption process of innovative technologies such as blockchain.

Integrating this theoretical framework makes it possible to understand the dynamic interaction between factors from a relational perspective, beyond addressing adoption at the individual and organizational level. In particular, TAM and UTAUT models that explain technology acceptance at the individual level are directly related to organizational structure and environmental factors. While individuals' perceptions towards technology are influenced by organizational factors, factors such as organizational readiness, resource allocation and top management support guide the individual acceptance process. Organizational factors considered in the TOE framework have a direct impact on individuals' intentions to adopt technology. For example, individual factors such as perceived usefulness and ease of use are strengthened by the technical infrastructure and supportive policies provided by organizations.

Similarly, the innovation characteristics offered by DOI theory (relative advantage, compatibility, complexity, observability, and trialability) play an important role in organizations' technology adoption decisions. How compatible the blockchain technology is with existing business processes or how organizations perceive the advantages of the innovation are among the factors that determine the speed and spread of the adoption process. The environmental factors (regulations, competitive pressures and market demands) considered in the TOE framework overlap with the social system component of DOI theory and explain the contextual dynamics of the adoption process.

The impact of environmental factors on adoption at the organizational level appears to be a determining factor in the adoption process of individuals. Competitive conditions and regulatory frameworks, which are evaluated within the TOE framework, are among the important factors that shape individuals' perceptions and tendencies towards technology adoption. For example, government incentives or sectoral regulations play an important role in the adoption of blockchain technology by organizations, while directly affecting individuals' perceived benefits and intention to use the technology.

The relational approach adopted in this study demonstrates that the factors affecting technology adoption interact with each other and that the process is too multifaceted to be explained by a single model. While individual adoption processes are influenced by organizational factors, organizations' adoption decisions are shaped by environmental factors and innovation characteristics.

As a result, the relational structure between the theoretical frameworks used in this thesis emphasizes that the blockchain adoption process should be considered within the interaction of individual, organizational and environmental factors. This approach allows for a more comprehensive analysis of the barriers and opportunities for blockchain technology adoption.

2.2. Literature Review

The power of blockchain to transform SCM processes, or the potential gains from blockchain envisioned, has been the focus of researchers' attention and has been explored in different contexts of SCM (Kshetri, 2018; Queiroz et al., 2019; Fosso Wamba et al., 2020). For example, blockchain-enabled SCM has given rise to various research topics such as transportation and logistics (Pournader et al., 2020), multi-echelon SCs (Manupati et al., 2020), global trade (Chang et al., 2020), sustainable SCs (Saberli et al., 2019; Zkik et al., 2023), humanitarian SCs (Dubey et al., 2020). Regardless of the topic, the consensus in studies on adopting blockchain is that the technology is still in its infancy (Fosso Wamba et al., 2020; Queiroz et al., 2020).

Despite the fact that blockchain technology is not yet mature enough and its potential benefits are not yet sufficiently explored, the interest of the academic community has gradually increased, and an accelerated increase in studies has been observed, especially in the last few years. Studies on adopting this technology in social sciences and engineering fields have increased. In this section, we will first present the current state of the academic literature and then critically evaluate the academic publications.

2.2.1. Current View of the Academic Literature

In order to understand the current state of the academic literature on the adoption of blockchain technology, research covering the period between 2009 and 2024 (June) was conducted. The Scopus database was preferred for this research. Scopus was chosen

because of the evidence that it is a comprehensive, qualified, and highly usable database in terms of interface in the literature on social sciences.

The Scopus database was searched using the keywords “(blockchain OR ‘block chain’) AND (‘supply chain’ OR logistic*) AND (adopt* OR accept*)” within the Article Title, Abstract, Keyword options. The search date range started from 2008, when the blockchain technology was announced, and extended until June 2024. Although the year 2008 was chosen as the beginning, according to our search criteria, it was seen that the publications on this platform started in 2017. In order to draw attention to the current situation in the literature, only Articles and Review Articles were included in the search.

According to the search results, a total of 1210 documents, 1082 Articles, and 128 Review Articles were reached. Figure 11 below reveals that the number of articles published each year since 2020 has increased by more than 50% compared to the previous year.

Figure 11

Number of Articles by Year

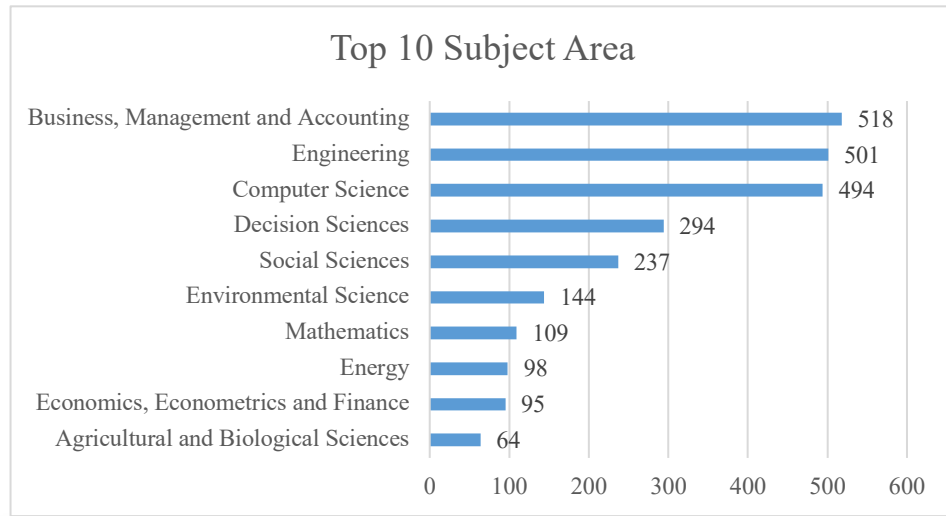


Source: Created by Author

Figure 12, shows the classification of these articles under Subject Area. According to the results, 1210 publications are distributed across 2815 subject areas, which can be explained by the fact that an article may appear in more than one subject area. Business, Management, and Accounting come first, followed by Engineering, Computer Science, and Decision Science. This shows that multidisciplinary studies are predominant.

Figure 12

Subject Area Classification of Articles

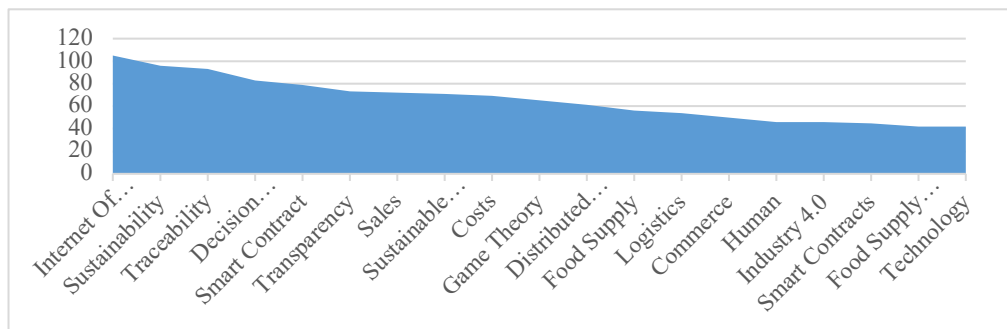


Source: Created by Author

Figure 13 shows the keywords frequently used in the articles. While creating this graph, words related to blockchain, technology adoption, and supply chain were excluded from our search words. Thus, it is seen that the five most frequently used keywords are IoT, Sustainability, Traceability, Decision Making, and Smart Contract.

Figure 13

Frequently Used Keywords (except technology adoption, blockchain, SCM related words) in Articles

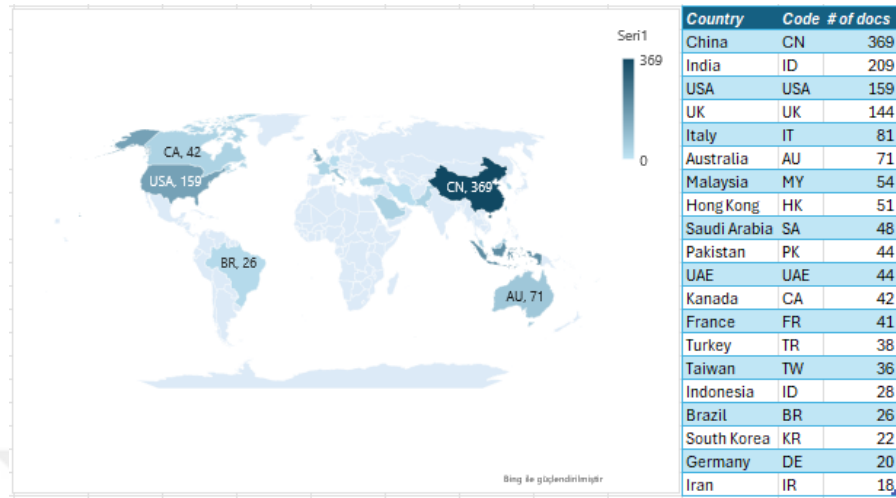


Source: Created by Author

Finally, Figure 14 shows the countries with the most publications in this field. China is the country with the highest number of publications, with 368 publications, followed by India, the USA, the UK, and Italy. Türkiye ranks 14th with 38 publications.

Figure 14

Countries by Number of Publications



Source: Created by Author

When the current state of the academic literature is examined, it is clearly seen that the studies on the adoption of blockchain technology in SCM have increased rapidly since 2020 and this field is a growing research topic. Studies in multidisciplinary fields such as Business, Management and Accounting; Engineering; and Decision Science show that blockchain technology has a wide range of applications. However, the fact that Türkiye ranks 14th in this literature with 38 publications reveals a relatively limited contribution to this growing field. Moreover, frequently studied themes such as IoT, Sustainability, Traceability, Decision Making and Smart Contracts point to important topics that blockchain research focuses on. Türkiye's strategic role in global trade and the need for region-specific insights to address the unique challenges and opportunities in this area, clearly demonstrates the necessity and importance of a study to identify the critical factors influencing the adoption of blockchain technology in SCM.

2.2.2. Critical Literature Review

The studies in the literature vary in terms of methodology, models used, and underlying theories. From a conceptual framework perspective, some studies have examined the adoption of blockchain technology within the global supply chain using the TOE framework (Clohessy et al., 2019; Clohessy & Acton, 2019; Orji et al., 2020; Vergouwen et al., 2020), while others have explored factors influencing the acceptance of blockchain technology using the UTAUT model (Queiroz & Fosso Wamba, 2019; Queiroz et al.,

2020; Wong et al., 2020). Another study by Janssen et al. (2020) developed a new framework called PIMT to identify the factors behind adopting blockchain technology.

When examining the methodologies used, some studies have identified the factors influencing blockchain adoption through systematic literature reviews (Clohessy et al., 2019; Saberi et al., 2019), while others have categorized and prioritized these factors using bibliometric analysis (Fosso Wamba et al., 2020), expert opinions (Vergouwen et al., 2020), or multi-criteria decision-making techniques (Ghode et al., 2020; Orji et al., 2020). Other studies have employed quantitative analysis methods such as Structural Equation Modeling (Queiroz & Fosso Wamba, 2019; Queiroz et al., 2020; Wong et al., 2020) and mixed methods (Werner et al., 2021). Additionally, a case study approach has been used to investigate these relationships (Clohessy & Acton, 2019).

From a TOE framework perspective, Clohessy et al. (2019), in their systematic literature review based on Tornatzky and Fleischer's (1990) TOE framework, summarized the factors influencing blockchain adoption and the frequency of significant variables identified in the literature. From the technology perspective, the benefits of adopting blockchain technology (e.g., immutability, security, fast transactions), the complexity of developing blockchain technology (e.g., verification algorithms, smart contract frameworks, DLT skills), and the compatibility of blockchain technology with existing technologies and systems (e.g., supply chain compatibility) are highlighted as key determinants. From an organizational perspective, factors such as organizational readiness (e.g., the knowledge and skills of human resources, infrastructure adequacy), top management support, and organizational size play a significant role in the adoption of this technology. Environmental factors such as the regulatory environment (e.g., lack of regulations) and market dynamics are also significant.

Similarly, another study using the TOE framework, Clohessy and Acton (2019), explored how organizational factors affect the adoption of blockchain in companies located in a developed country. They conducted a case study involving 20 companies based in Ireland and investigated how the top three organizational factors identified in the literature influenced these companies' decisions to adopt or not adopt blockchain technology. The results indicated that top management support and organizational readiness are enablers of blockchain adoption, and large companies are more likely to adopt blockchain compared to small and medium-sized enterprises (SMEs). Additionally, the speed of

technology was identified as a concern for participants struggling to keep up with technological demands.

In another study using the TOE framework, Orji et al. (2020) analyzed the critical factors influencing the successful adoption of blockchain technologies in the freight logistics industry, using the Analytic Network Process (ANP) to prioritize them. The findings revealed that the "availability of specific blockchain tools," "infrastructure facility," and "government policy and support" are the top three factors influencing blockchain adoption in the logistics industry.

In addition, Vergouwen et al. (2020) evaluated the factors influencing blockchain adoption in the Netherlands based on expert opinions. The study, which involved eight blockchain experts, identified 16 factors that matched existing literature and two new factors previously unaddressed: "willingness to collaborate" and "problem matching." The study also identified the lack of regulation and the shortage of blockchain experts as the two biggest barriers to adoption.

In a notable study, Janssen et al. (2020) proposed a new conceptual framework similar to the TOE framework to capture the challenges and issues related to blockchain adoption. The authors developed the PIMT (Process, Institutional, Markets, and Technology) framework to facilitate the adoption of blockchain technology.

According to UTAUT framework perspective, Queiroz and Fosso Wamba (2019) empirically analyzed the individual factors influencing blockchain adoption in India and the USA by extending the UTAUT model. In this model, the authors modeled performance expectancy, effort expectancy, social influence, and facilitating conditions as external constructs to predict behavioral intention and usage, and integrated two new constructs (blockchain transparency and supply chain stakeholder trust) to form the model. The model was then estimated using Partial Least Squares Structural Equation Modeling (PLS-SEM). Since the model was supported, the findings revealed different adoption behaviors between professionals based in India and the USA. For example, the effect of facilitating conditions on adoption intention was found to be significant only in the Indian sample. Another important finding of the study was that the newly added variable reflecting trust in supply chain stakeholders only influenced behavioral expectations regarding blockchain adoption in India. This model did not use the moderator variables of the original UTAUT model (gender, age, experience, and

voluntariness of use). Additionally, effort expectancy was not included in the analysis, as it was not considered distinctive at the early stages of technology adoption.

Similarly, another study based on the UTAUT model by Queiroz et al. (2020) empirically tested the factors influencing blockchain adoption in a developing country using the Brazilian country example and Partial Least Squares Structural Equation Modeling (PLS-SEM). In their study, the authors developed a model based on the UTAUT supply chain literature, and emerging literature on blockchain technology (BCT). The study's results identified facilitating conditions, trust, social influence, and effort expectancy as the most critical constructs directly affecting BCT adoption, while performance expectancy was not found to be a significant variable.

Additionally, Wong et al. (2020) expanded the UTAUT model to include Technology Readiness (TR), Trust (TT), Technology Affinity (TA), and Regulatory Support constructs to identify the determinants of blockchain adoption in SCM in Malaysia. The WarpPLS analysis of data collected from 157 firms revealed that Facilitating Conditions (FC), Technology Readiness (TR), and Technology Affinity (TA) positively influenced the intention to use blockchain-supported SCM. Furthermore, regulatory support mitigated the effect of FC. In the saturated model, Performance Expectancy (PE), Effort Expectancy (EE), and Trust (TT) were not statistically significant.

Moreover, Werner et al. (2021) examined the impact of blockchain adoption on the competitive performance of firms in an inter-organizational context using a mixed-methods approach. The study's findings indicate that blockchain technology positively affects competitive performance by providing traceability and immutability, and enhance partnership flexibility through smart contracts. Fosso Wamba et al. (2020) revealed the benefits, challenges, and research opportunities related to blockchain technology through bibliometric analysis. This study highlighted the countries with the most publications on blockchain, the most cited studies, and the main themes and trends in this technology.

Additionally, Ghode et al. (2020) aimed to identify and prioritize the factors and challenges influencing blockchain adoption in supply chains by conducting a literature review and using expert opinions in a Grey Relational Analysis (GRA). The eight factors identified were inter-organizational trust (IO), relational governance (RG), interoperability (IP), product type (PT), data transparency (DT), data immutability (DI), social influence (SI), and behavioral intention (BI). The study ranked these factors as

follows: IO, IP, RG, DT, DI, BI, PT, and SI. IO and RG were categorized as organizational challenges; DT and DI as technological challenges; IP and PT as operational challenges; and BI and SI as social challenges. In another study, Ghode et al. (2021) used Interpretive Structural Modeling (ISM) to model the challenges in blockchain adoption within supply chains. The challenges identified through literature review and expert opinions included inter-organizational trust, governance, transparency, immutability, exchange of information, selection of products, societal change, and participant behavior. The analysis concluded that governance was the most significant challenge. Furthermore, Frizzo-Barker et al. (2020) conducted a systematic literature review guided by the PRISMA framework, highlighting not only the current benefits and challenges of blockchain technology but also pointing out that existing research is still in its early stages and insufficient.

In addition to academic studies, various institutions have published reports on blockchain technology. For instance, a report by Deloitte published in 2020, the Global Blockchain Survey, provides insights into the adoption of blockchain technology (Pawczuk et al., 2020). According to the survey, awareness of blockchain adoption and attitudes toward this technology have improved. In fact, compared to 2018, there was a significant increase in blockchain adoption in 2020. Approximately one-fifth of the 1,488 survey respondents indicated that cybersecurity concerns are hindering the development of this technology. Additionally, a notable point in this report, consistent with the academic literature, is that the barriers to blockchain adoption are unique to organizations' specific characteristics or conditions. The current obstacles identified in this report, ranked by severity, are as follows: implementation (replacing or adapting existing legacy systems), potential security threats, concerns about the sensitivity of competitive information, lack of regulatory clarity, lack of internal skills (expertise and understanding), difficulties in forming consortia, burdensome regulatory environment, uncertain return on investment, and insufficient funding.

Recent studies (2022-2024) indicate that research in this area continues to grow. On one hand, there is an increase in studies investigating blockchain adoption factors in specific areas such as supply chain sustainability (Zkik et al., 2023), risk management (Cai et al., 2023), finance (Kaur et al., 2024), and global supply chain value management (Hubenova et al., 2024). On the other hand, the literature is shifting towards integrated models that

explain adoption behaviors using new theories such as Social Network Theory (Patil et al., 2023) and combined models like TOE, Institutional Theory, and IS Success Model (ISM) (Shahzad et al., 2024). Additionally, due to the nature of blockchain technology, studies in the agricultural sector that were initiated in previous years continue (Oguntegbe et al., 2022), with a transition from empirical studies involving participants from various sectors (Alazab et al., 2021; Chittipaka et al., 2023) to sector-specific studies (e.g., the manufacturing industry by Tasnim et al., 2023; and the retail supply chain by Mukherjee et al., 2023).

In this recent literature, certain studies stand out. For example, Zkik et al. (2023) examined the impact of blockchain technology (BT) on sustainable supply chain performance (SSCP) in the context of agricultural supply chains. They identified 21 barriers related to governance, management, technology, human resources, and supply chains.

Furthermore, 15 enablers have been identified to overcome these barriers and achieve Sustainable Supply Chain Performance (SSCP) through Blockchain Technology (BT). Using a hybrid approach that includes Pythagorean Fuzzy sets (PFS), Cumulative Prospect Theory (CPT), and VIKOR, data from 215 agricultural firms in Asia and North Africa were analyzed to identify the barriers and enablers of BT adoption. The results suggest strategies for BT implementation, including transparency, collaboration, data access control, management commitment, and cooperation with governments (Zkik et al., 2023).

In their study, Cai et al. (2023) examined the intention of supply chain managers to adopt blockchain technology from the perspective of supply chain risk management. Using a survey sample of 203 managers from China and the USA, they expanded the technology acceptance model to investigate the impact of four perceived benefits of blockchain technology on supply chain risk resilience. The results show that blockchain's features, such as traceability, transparency, information sharing, and decentralization, enhance the perceived benefits of blockchain in terms of supply chain resilience and responsiveness and improve the ability to withstand disruption risks and supply-demand coordination risks. Additionally, the relationships between supply chain resilience and blockchain adoption, and between supply chain responsiveness and blockchain adoption, are more pronounced for managers with a high level of uncertainty avoidance.

As well as that, Kaur et al. (2024) investigated the significant barriers to blockchain adoption in supply chain finance practices among SMEs in India. Based on a comprehensive literature review and expert opinions from academia and industry, 25 sub-barriers were identified under six main barriers. The study used the Fuzzy Analytical Hierarchy Process (Fuzzy-AHP), Fuzzy Decision-Making Trial and Evaluation Laboratory (Fuzzy-DEMATEL), and sensitivity analysis to identify, prioritize, and analyze the cause-and-effect relationships of these blockchain barriers. The results show that technological barriers are the most significant obstacles to blockchain adoption, followed by organizational and security barriers.

Besides, Hubenova et al. (2024) adopted a micro-level perspective to explain the uneven adoption of blockchain technology in the global value chains (GVCs) of multinational enterprises (MNEs). The study emphasizes that although blockchain technology has the potential to create unique advantages for firms, its adoption is inconsistent. By focusing on the influence of Technology, Organization, and Environment (TOE) factors on the TAM, the study explored how managers' perceptions of blockchain's usefulness and ease of use impact adoption. The research used a multiple-case study design based on interviews with supply chain managers from small, medium, and large-scale manufacturing MNEs operating in GVCs with different management patterns. The results identified 15 different drivers of non-adoption of blockchain technology within the technological, organizational, and external environments of MNEs. The findings present a parsimonious model of blockchain non-adoption using the TOE-TAM approach, consistent with the digital technology adoption literature. Critically, the explanation for blockchain non-adoption falls into four categories: (1) managerial microfoundations, (2) characteristics of blockchain technology, (3) characteristics of organizations (MNEs), and (4) characteristics of firms' supply chains. The findings suggest that the low technological maturity of blockchain, the lack of example use cases, the low complexity of SCM, and the limited managerial understanding of blockchain technology explain its non-adoption from a micro-level perspective. Despite arguments for adoption, the findings suggest that large-scale adoption of blockchain technology in MNE GVCs will be unlikely in the near future.

On the other hand, it has been observed that new theories are being integrated into blockchain adoption studies, and even integrated models are becoming the focus of

research. In another noteworthy study, Patil et al. (2023) examined the main factors influencing blockchain assimilation based on social network theory and analyzed the impact of supply chain learning, collaboration, and network importance on blockchain adoption. This study, conducted with the participation of 150 supply chain professionals, is a pioneering effort to understand the behavioral drivers of blockchain assimilation at the organizational level. Collaborative interactions and learning processes within supply chains are emphasized as critical for profitable and sustainable supply chain innovation. Additionally, the study highlights that supply chain interactions defined by networked organizations lead to blockchain adoption and underscores the necessity of collaborative networks and learning for effective supply chain innovation.

In addition, Shahzad et al. (2024) integrated the TOE, Institutional Theory, and IS Success Model (ISM) to examine pre- and post-adoption factors of blockchain adoption in supply chains. They considered behavioral intention as the pre-adoption stage and blockchain infusion as the post-adoption stage. Using data collected from 272 senior managers of supply chain organizations in China, PLS-SEM results show that pre-adoption factors such as traceability, transparency, organizational readiness, coercive pressure, and normative pressure positively influence BT adoption, while security concerns negatively impact adoption. The study also examined the post-adoption scenario using the ISSM model, confirming that actual blockchain usage positively affects blockchain infusion and SCM performance. Additionally, the results indicated that firm size influences behavior, with larger organizations exhibiting higher readiness and fewer concerns. They defined infusion as the optimal use of BT in SC operations.

Moreover, the study by AlKubaisy and Al-Somali (2023) examined blockchain adoption in the supply chain and logistics sector in Saudi Arabia. The research was conducted via a survey with data collected from 403 senior employees, including managers, IT specialists, and logistics professionals from 71 Saudi supply chain and logistics companies. The focus was on medium and large-scale organizations, as these typically have stronger financial resources and greater capability to overcome technological challenges. The results present that relative advantage, top management support, and competitive pressure significantly and positively influence blockchain adoption. Government support had the strongest positive impact on blockchain adoption, while openness to innovation and vendor support did not show a significant effect. Additionally,

the study found that while the direct impact of cultural compatibility of blockchain solutions on operational excellence was significant, the moderation effect between blockchain adoption and operational excellence was not significant.

Furthermore, studies conducted in specific sectors have also gained attention in the literature. The agricultural sector has been frequently examined in blockchain research due to its potential benefits. In their article, Oguntegbe et al. (2022) investigated the behavioral and organizational antecedents influencing blockchain adoption in agri-food supply chains. The study employed thematic analysis of blockchain-related agri-food business news and expert opinions sourced from the Agricola section of the Ovid database. Four main themes were identified: organizational adoption strategies, technical advantages, environmental barriers, and intention to adopt. The findings indicate that managers recognize the benefits of blockchain technology and adopt strategies to capitalize on new opportunities. However, environmental barriers such as market fragmentation, lack of research, and regulatory constraints are also identified as significant factors. This study supports the arguments of the Behavioral Reasoning Theory (BRT) and Technology, Organization, and Environment (TOE) Framework.

Also, Tasnim et al. (2023) used a conceptual model integrating TAM and TOE models to examine the intention to adopt blockchain technology in SCM in the manufacturing industries in Bangladesh. The study was empirically tested using data collected from 189 supply chain managers. The findings reveal that perceived usefulness, pressure from trading partners, and competitive pressure are the most influential factors affecting the intention to adopt blockchain technology. Additionally, it was found that most participants were unaware of blockchain technology and lacked knowledge about its benefits and challenges. Only 19% of participants reported implementing blockchain technology, while 34% stated that they were unaware of this technology. This indicates that despite extensive briefing, the lack of knowledge persists.

As well as that, Mukherjee et al. (2023) investigated the behavioral intentions of retail employees towards the adoption of blockchain technology in the retail supply chain using the TAM, UTAUT, and TPB theories. The study analyzed a dataset of 356 respondents, collected both online and offline from various retail stores in India, using exploratory factor analysis and structural equation modeling. The findings indicate that retail store employees have a positive attitude and intention towards adopting blockchain technology.

However, perceived behavioral control and effort expectancy were not found to encourage blockchain adoption.

Moreover, Shahzad et al. (2023) differentiated their study from previous literature by focusing on the continuity of acceptance intention instead of adoption intention. By expanding the UTAUT2 model with additional factors such as personal innovativeness and user self-efficacy, they explored the factors influencing the continuous intention to use and accept blockchain technology in SCM. Data collected from 252 respondents in Beijing, China, were analyzed using structural equation modeling (SEM) with AMOS software. The empirical results confirm the critical role of performance expectancy, facilitating conditions, price value, hedonic motivation, habit, user self-efficacy, personal innovativeness, and user satisfaction in sustaining the intention of supply chain professionals to use and accept blockchain technology in SCM.

Chittipaka et al. (2023) examined the adoption of blockchain technology in supply chains using the TOE framework in India. The study collected data via surveys from 525 SCM professionals in India and tested the research model using structural equation modeling (SEM). The study found that eleven TOE constructs—relative advantage, trust, compatibility, security, firm's IT resources, top management support, firm size, financial resources, competitive pressure, partner pressure, and regulatory pressure—significantly influenced the decision to adopt blockchain technology. Alazab et al. (2021) explored the factors that hinder or facilitate blockchain adoption in supply chains by integrating the UTAUT, TTF, and ISS models, using data from surveying 449 firms across various industries. The analysis, conducted using PLS-SEM, found that the ISS, TTF, and UTAUT models positively impacted the factors influencing supply chain employees' willingness to adopt blockchain. The results indicate that the social influence factor of the UTAUT model did not significantly affect blockchain adoption intention. However, inter-organizational trust significantly impacted the relationship between the UTAUT dimension and blockchain adoption intention. Table 4, below presents selected literature on the BTA.

Table 4 presents the factors investigated in selected literature regarding the adoption of blockchain in the context of the supply chain. The full list of factors identified through a systematic literature review, along with references, is reported in Chapter 3.

Table 4*Selected Literature on the Adoption of Blockchain*

<i>References</i>	<i>Method</i>	<i>Theoretical Backgrounds</i>	<i>Sample</i>	<i>Key Findings</i>
Cai et al., (2023)	Survey	TAM	203 supply chain managers in China (97) & USA (106)	Blockchain enhances resilience, responsiveness, disruption resistance.
Hubenova et al., (2024)	Multiple Case Study	Micro Foundations, TOE	12 MNE managers	Barriers: low blockchain maturity, insufficient knowledge.
Kaur et al., (2024)	Fuzzy AHP & DEMATEL	Resource-based View	58 supply chain professionals + 15 experts	Barriers: tech > organizational > security.
Shahzad et al., (2024)	PLS-SEM	TOE & Institutional Theory	272 executives in China	Key factors: traceability, transparency, readiness; security concerns hinder.
Mukherjee et al., (2023)	SEM	TAM, UTAUT, TPB	356 retail employees in India	Positive attitudes: effort expectancy does not encourage adoption.
Patil et al., (2023)	OLS Regression	Social Network Theory	150 supply chain professionals	Networks, organizational learning drive blockchain innovation.
Samad et al., (2023)	ISM & DEMATEL	TOE	12 industry and academic experts	Enablers: traceability, immutability, real-time connectivity.
Tasnim et al., (2023)	PLS-SEM	TAM, TOE	189 supply chain managers in Bangladesh	Factors: perceived usefulness, competitive pressure, lack of knowledge.
Vafadarnikjoo et al., (2023)	N-AHP	TOE	6 experts in Iranian manufacturing firms	Top barrier: transaction-level uncertainties.
Agi and Jha, (2022)	LR & DEMATEL	DOI	37 French supply chain experts	Key enablers: relative advantage, external pressure.
Chittipaka et al., (2023)	SEM	TOE	525 SCM professionals in India	Key factors: trust, compatibility, security, management support.
Dehghani et al., (2022)	Mixed Methods	TOE	25 interviews + 146 surveys	Factors: data quality, interoperability, lack of knowledge, standardization.
Gökalp et al., (2022)	SLT & AHP	TOE	30 experts in UK & Türkiye	Environmental factors rank higher than tech and organizational.
Oguntegbe et al., (2022)	Thematic Analysis	BRT, TOE	Agri-food industry	Key themes: strategies, technical advantages, environmental barriers.
Alazab et al., (2021)	PLS-SEM	UTAUT, TTF, ISS	104 firms across sectors	Inter-organizational trust is critical; social influence less impactful.
Kouhizadeh et al., (2021)	DEMATEL	TOE	35 academics, 12 industry experts	Insights: stakeholders and institutional barriers influence adoption.

Table Continued

Kouhizadeh et al., (2021)	DEMATEL	TOE	35 academics, 12 industry experts	Insights: stakeholders and institutional barriers influence adoption.
Ghode et al., (2021)	ISM & Expert Opinions	-	5 blockchain experts	Challenges: trust, governance, transparency, immutability, participant behavior.
Kumar Bhardwaj et al., (2021)	CFA & SEM	TAM, DOI, TOE	216 SMEs in India	Positive factors: compatibility, management support; Barriers: complexity, cost.
Treiblmaier et al., (2021)	Survey + Interviews	Intra-/Inter-org. Barriers	190 supply chain experts + 10 interviews	Key barriers: lack of understanding, legacy system integration.
Choi et al., (2020)	CFA & PLS-SEM	TOE	Survey with 83 participants	Key barriers: technological, organizational, environmental, and governmental.
Fosso Wamba et al. (2020)	PLS-SEM	UTAUT	India & USA	Behavioral differences: Supply chain trust impacts adoption in India; facilitating conditions less significant in India.
Ghode et al., (2020)	Literature Review & GRA	-	5 academicians & practitioners	Ranked factors: inter-organizational trust, governance, transparency, interoperability, and behavioral intention.
Orji et al., (2020)	ANP	TOE	Literature + 4 experts	Influential factors: blockchain tools, infrastructure, government policies.
Queiroz et al., (2020)	PLS-SEM	UTAUT	184 firms in Brazil	Critical factors: trust, facilitating conditions, effort expectancy.
Vergouwen et al., (2020)	Expert Opinions	TOE	8 blockchain experts in the Netherlands	Key barriers: lack of regulation, shortage of experts.
Wong et al., (2020)	SEM	UTAUT	157 firms in Malaysia	Readiness, facilitating conditions drive adoption; regulatory support moderate impact.
Clohessy and Acton (2019)	Case Study & Content Analysis	TOE	20 Ireland-based companies	Top management supports adoption of aid; rapid tech changes hinder smaller companies.
Saberi et al., (2019)	SLR	-	Expert opinion	Barriers categorized as internal, inter-org., system-related, and external.

The studies in the literature provide an essential resource for understanding the adoption and impact of blockchain technology in supply chains, revealing differences in applications and adoption behaviors across various sectors. In this context, a more comprehensive examination of the factors influencing the adoption of blockchain in supply chains and the impact of this technology on supply chain performance is needed.

The most general proposition that can be reached from studies on blockchain technology is that, regardless of the sector, country, or theory, the factors influencing blockchain adoption are highly diverse and multidimensional. Therefore, this topic has content and significance that requires in-depth examination.

Considering the limited literature investigating the adoption of blockchain technology, it can be concluded that numerous factors influence its acceptance. These factors, addressed in different categories by various authors, vary from country to country. More importantly, both individual characteristics, organizational traits, and the external environment are decisive in the acceptance of blockchain technology. Therefore, studies on the adoption of blockchain technology should be approached in different countries, industries, and even organizations to validate or diversify the existing literature results.

The factors influencing the decision to adopt blockchain can be viewed as either barriers or enablers. Additionally, the unit of analysis can be selected in either an individual or organizational context. Studies that focus on the organizational context can extend the framework by grounding it in the TOE (Technology-Organization-Environment) framework, and new categorization examples of internal or inter-organizational barriers can be found (see Treiblmaier et al., 2021). Furthermore, examples in the literature include the analysis of organizational sizes, whether an organization is a startup or an incumbent, or an in-depth analysis of a specific sector. Consequently, it is clear that the acceptance of such a multifaceted technology cannot be explained by a single theory.

CHAPTER 3. RESEARCH METHODOLOGY

In this chapter, the research problem, objectives, and goals of the study are outlined. Subsequently, the research design and methodology are detailed. In alignment with the research design, the methods and findings of each study stage are presented. Following this, the quantitative and qualitative analysis results are compared.

3.1. Research Problem

The main purpose of this dissertation is to identify, categorize, and prioritize the critical factors influencing the adoption of blockchain technology in Türkiye's SCM, while uncovering contextual dynamics and developing actionable strategies based on expert perspectives to facilitate this process. With this purpose, the following research questions have been formulated. Each research question is associated with a specific aim and goal to achieve detailed insights into various aspects of blockchain technology adoption in SCM in Türkiye. These are presented in the Table 5.

Table 5

Research Questions, Aims and Goals of the Dissertation

Research Questions (RQ)	Aims (A)	Goals (G)
RQ1: What are the critical factors affecting the adoption process of blockchain technology in Turkish SCM? How can these factors be categorized based on TAM, UTAUT, TOE, and DOI frameworks?	A1: Identification and categorization of factors influencing the adoption of blockchain technology in SCM .	G1: Identify the critical factors affecting the adoption of blockchain in SCM. G2: Categorize the identified factors based on TAM, UTAUT, TOE, and DOI frameworks.
RQ2: Which factors should be prioritized in the adoption process of blockchain technology in SCM in Türkiye, and do the importance levels of these factors vary according to different expert profiles (academia, private sector, public sector)?	A2: Determination of the importance levels and priority rankings of the identified critical factors in the context of SCM in Türkiye.	G3: Determine the factors that should be prioritized in the adoption process of blockchain in SCM in Türkiye. G4: Examine whether the importance levels of these factors vary according to different expert profiles (academia, private sector, public sector).

Table Continued

RQ3s: RQ3a: What are the contextual and perceptual dynamics underlying the adoption of blockchain technology in Türkiye's SCM? RQ3b: What new factors influencing adoption can be identified through qualitative insights? RQ3c: What actionable strategies based on expert perspectives can be proposed to address these barriers and accelerate blockchain adoption in Türkiye	A3: Exploration of the contextual and perceptual dynamics influencing blockchain adoption in Türkiye's SCM, the identification of new factors contributing to the adoption process, and the development of actionable strategies based on expert perspectives to address barriers and facilitate adoption through qualitative analysis.	G5: To investigate the underlying contextual and perceptual factors influencing blockchain adoption in Türkiye's SCM. G6: To identify new factors or barriers that emerge from qualitative insights specific to Türkiye's economic, cultural, and technological context. G7: To develop actionable strategies based on expert perspectives based on qualitative findings to address the identified barriers and facilitate blockchain adoption in Türkiye's SCM.
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Source: Created by Author

3.2. Research Design

In the light of Creswell and Clark (2017), the mixed methods approach, which combines quantitative and qualitative research methods, has been adopted in this dissertation. More specifically, the Explanatory Sequential Design has been employed. Mixed method research designs enable researchers to integrate numerical data with in-depth, contextual information, thereby enabling a more comprehensive and holistic understanding. As Creswell and Clark (2017) note, mixed methods are employed when a single data source is insufficient, an results need to be explained, or when a theoretical stance needs to be developed by using quantitative and qualitative methods. Additionally, using mixed methods allows research questions to be addressed from multiple dimensions, enhancing the reliability of the findings.

There are several basic types of mixed method research designs: The Convergent Parallel Design involves collecting and analyzing quantitative and qualitative data simultaneously, with the results typically merged for interpretation. The Explanatory Sequential Design starts with collecting and analyzing quantitative data, followed by collecting qualitative data to explain these results. The Exploratory Sequential Design

begins with collecting and analyzing qualitative data, followed by quantitative data collection to test or generalize the initial findings. The Embedded Design incorporates supplementary data collection within a primary quantitative or qualitative design. The Transformative Design is framed within a theoretical perspective, such as social justice or change. The Multiphase Design involves using quantitative and qualitative methods across different program phases.

Several key considerations must be considered when selecting a mixed methods design. The chosen design must align with the research problem and questions. The timing of quantitative and qualitative data collection phases (concurrent or sequential) must be determined. Deciding which method (quantitative or qualitative) will be given more prominence is also essential. Finally, strategies for integrating and analyzing quantitative and qualitative data must be defined.

In this study, the Explanatory Sequential Design guided the research process. Initially, a quantitative ranking analysis identified and systematically prioritized factors affecting blockchain adoption based on literature. While this stage, highlighted general trends, it was insufficient to uncover the contextual and perceptual dynamics underlying these findings.

To overcome this limitation, qualitative analysis was conducted in the second stage of the study. The qualitative analysis explained and contextualized the quantitative findings in depth and elaborated on the perceptual and contextual foundations behind the factors that stood out in the ranking. In addition, new factors and strategies specific to the Turkish context were identified in this process. Türkiye's unique economic, cultural, and technological dynamics have been taken into account, revealing elements that have not yet been addressed in the literature.

The sequential and complementary nature of the two methods provided comprehensive and holistic answers to the research questions. Quantitative analysis provided a broad framework, while qualitative analysis deepened this framework, enabling the research to produce context-sensitive and meaningful results. This methodological choice provided the opportunity to explain not only general trends but also the causes and contextual dynamics of these trends.

The advantages of the Explanatory Sequential Design include providing in-depth understanding by explaining quantitative findings with qualitative data, the step-by-step

analysis process that allows each phase's results to guide the next phase, and the adaptability to plan and implement the second phase based on the results of the first phase. The disadvantages include the time and resource requirements, as the two-phase process can be more costly, the complexity of collecting and analyzing different data types, and the need for expertise in quantitative and qualitative research methods.

Table 6 contains the characteristics of the Explanatory Sequential Design.

Table 6

Explanatory Sequential Design Characteristics with Explanations

<i>Characteristic</i>	<i>Explanation</i>
<i>Definition</i>	The explanatory sequential design involves collecting and analyzing quantitative data first. The results from this phase guide the subsequent qualitative phase, where qualitative data is collected and analyzed to explain the initial quantitative findings in more depth.
<i>Design Purpose</i>	This design is particularly useful when there is a need to explain quantitative results that are significant, nonsignificant, or unexpected.
<i>Typical Paradigm Foundation</i>	The quantitative phase is grounded in a postpositivist paradigm, focusing on measuring variables and testing hypotheses. The qualitative phase adopts a constructivist approach, emphasizing understanding participants' perspectives.
<i>Level of Interaction</i>	The interaction between the quantitative and qualitative phases is essential, as the results from the first phase inform the design and implementation of the second phase.
<i>Priority of the Strands</i>	In this design, the quantitative phase is prioritized, providing a foundation for the qualitative phase.
<i>Timing of the Strands</i>	The phases are implemented sequentially, with the quantitative phase occurring first, followed by the qualitative phase.
<i>Primary Point of Interface for Mixing</i>	The primary point where the two phases intersect is during data collection, where the quantitative results determine the qualitative data collection process.
<i>Primary Mixing Strategies</i>	Strategies include using quantitative results to shape qualitative research questions, sampling, and data collection methods, ensuring the qualitative phase addresses gaps or questions arising from the quantitative phase.
<i>Common Variants</i>	Common variants include conducting follow-up explanations based on quantitative results and using <i>quantitative</i> findings to select participants for the qualitative phase.

Source: Creswell & Clark (2017), adapted by the author.

In this context, the Explanatory Sequential Design provided a comprehensive and multidimensional approach to the research problem. Design has made valuable contributions, particularly in the following areas:

- Examination of the reasons behind the prioritization of certain factors,
- Exploring context-based barriers and challenges specific to the blockchain adoption process,
- Providing a richer understanding by uncovering new insights that were not highlighted in the quantitative phase.

This methodological approach allowed the research to be structured in such a way that the quantitative and qualitative findings complemented each other and provided an in-depth analysis of the blockchain adoption process.

3.3. Research Method

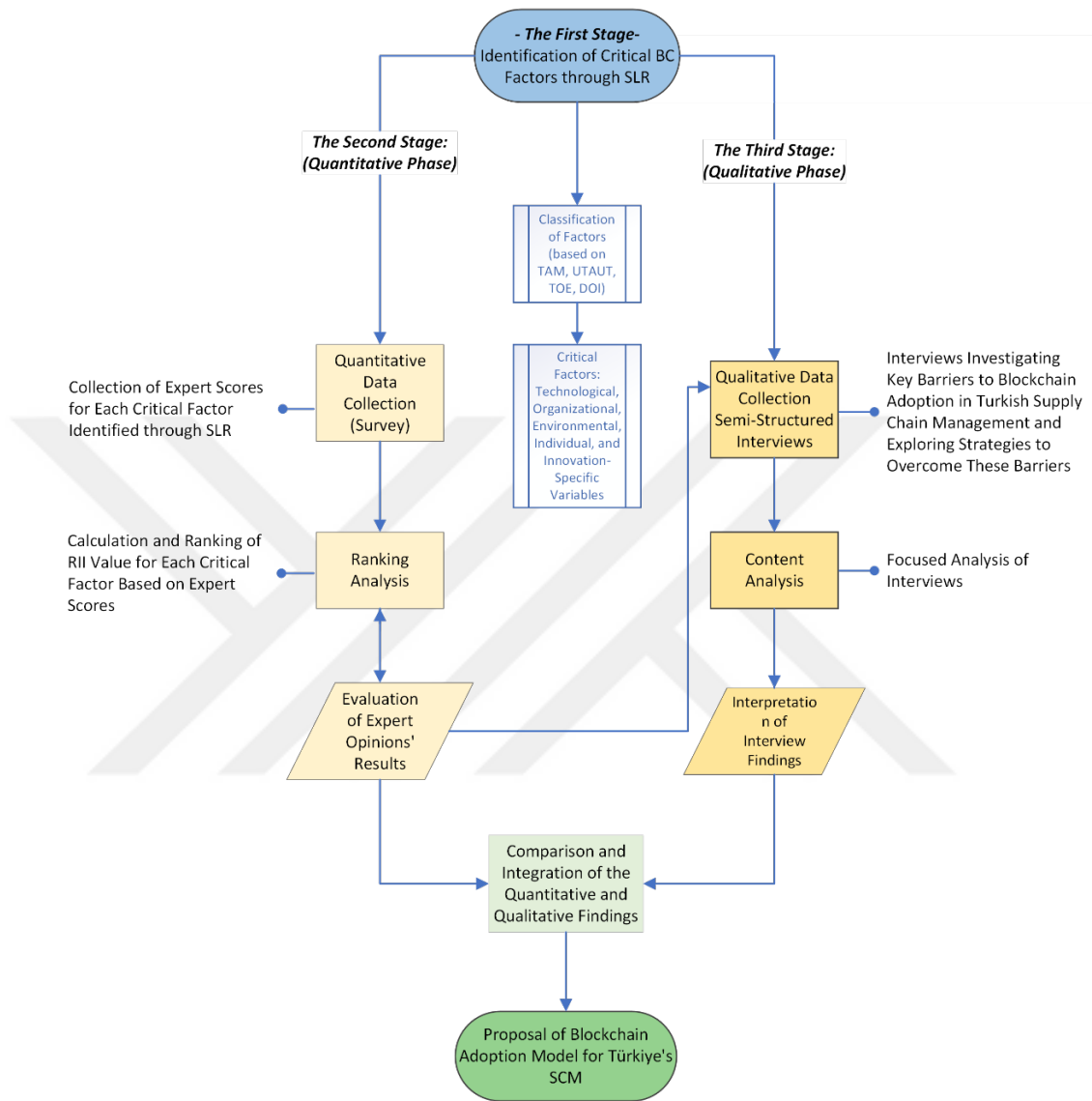
The main objective of this dissertation will be achieved through a three-stage research design addressing the identified research questions. These phases include a systematic literature review (SLR), quantitative sequence analysis, and basic qualitative research based on a focused analysis of interviews.

Each method is described in detail in the dissertation to ensure a comprehensive understanding of the research approach.

Figure 15 below shows the workflow diagram followed throughout the methodology chapter.

Figure 15

Workflow Diagram of the Research Method for Blockchain Adoption in Türkiye's SCM



Source: Created by Author

3.4. Stage 1- Systematic Literature Review of Blockchain Adoption Factors

To identify the critical factors influencing the adoption of blockchain technology in SCM, the Systematic Literature Review (SLR) technique will be employed. A SLR involves secondary research processes, including locating primary studies on a specific research topic, critically evaluating them, categorizing and analyzing the findings, synthesizing results, and reporting conclusions (Tranfield et al., 2003; Kitchenham et al., 2010).

Systematic reviews effectively assess and interpret all existing research related to a particular research question, topic area, or phenomenon of interest (Kitchenham, 2004). These reviews aim to compile, review, and summarize existing knowledge and identify gaps in a meta-analysis (Frizzo-Barker et al., 2020). Traditional literature reviews often rely on the subjective assessments of researchers, whereas systematic literature reviews strive to yield more objective and reproducible results.

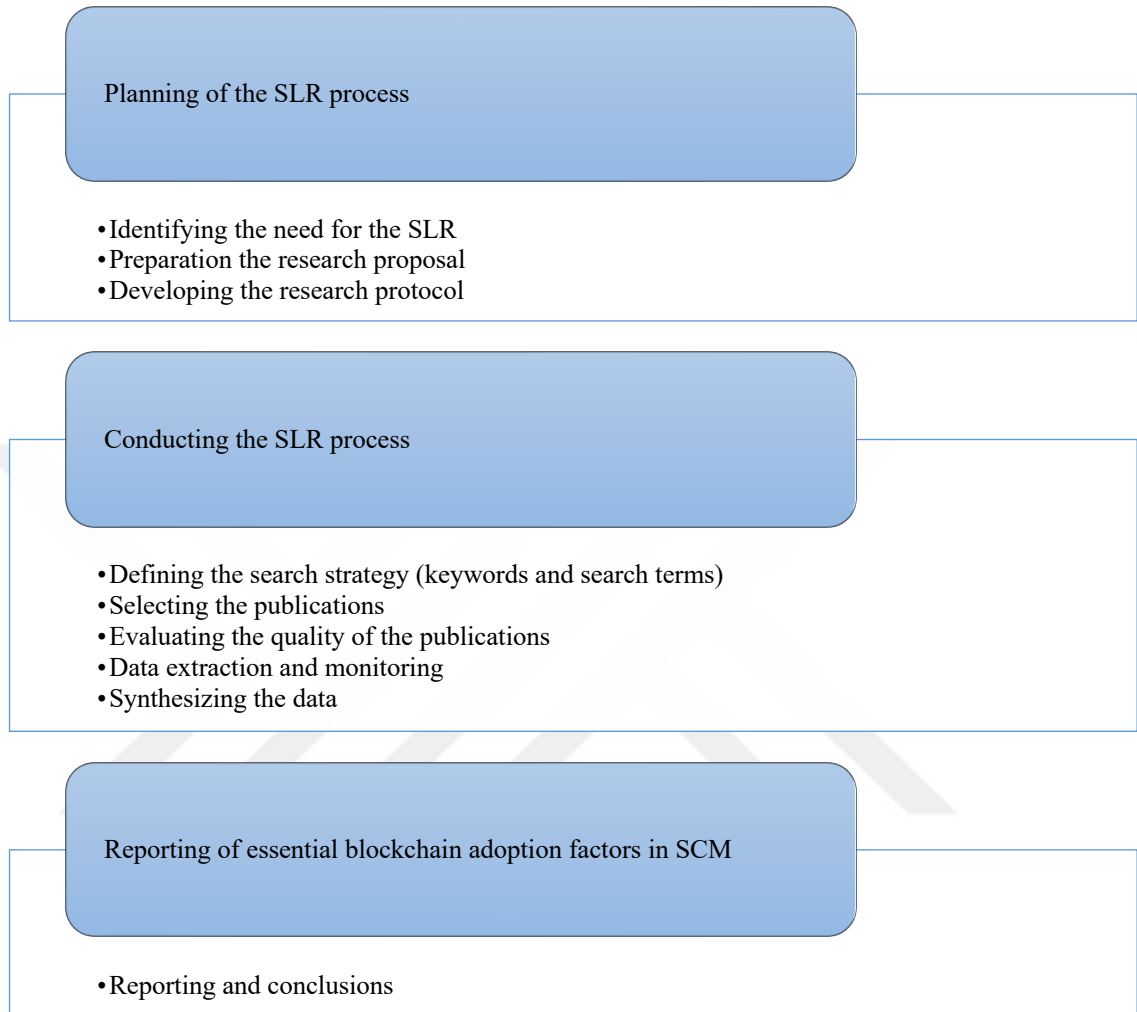
Recently, social scientists have increasingly adopted systematic reviews to comprehend complex and emerging fields of study. This trend is driven by the rapid proliferation of research across various academic channels, including books, journals, social media, and websites, making systematic reviews crucial for scholars (Frizzo-Barker et al., 2020).

Frizzo-Barker et al. (2020) highlight that systematic literature reviews (SLRs) are an effective exploratory methodology for early-stage research on blockchain technology. Systematic reviews help bridge the “research-practice gap,” particularly in areas lacking practical applications (Rousseau, 2006). By comprehensively evaluating existing literature, systematic reviews provide clear answers to research questions and establish a robust foundation for new research areas.

In this dissertation, the SLR technique proposed by Tranfield et al. (2003), which consists of three phases: Planning, Conducting, and Reporting, will be implemented. This technique is preferred due to its wide acceptance in the academic community (with 16,651 citations), its applicability, and the clarity and transparency of its processes.

Figure 16

Phases of SLR Process



Source: Tranfield et al. (2003)

3.4.1. Planning of the SLR process

According to Tranfield et al. (2003), the planning stage involves identifying the need for the review, preparing a review proposal, and developing the review protocol. This step is crucial to ensure that the systematic literature review (SLR) is methodologically sound. Since the need for identification and review proposal preparation has been explained throughout the dissertation, the focus will be on the research protocol. The planning step concludes with the development of the research protocol. The following Table 7 illustrates the research protocol, which defines the scope and boundaries of the SLR process.

Table 7*Research Protocol*

Research Protocol	Detailed Description
Database	Scopus
Publication Types	Articles & Review Articles
Language	Only English and Turkish Articles
Date Range	The studies published from 2009 to 2022 will be included. The starting year 2009 was chosen because blockchain technology was first introduced in October 2008 with Satoshi Nakamoto's paper "A Peer-to-Peer Electronic Cash System."
Search Field	Title, Abstract & Keywords
Search Query	(blockchain OR "block chain") AND ("supply chain" OR logistic*) AND (adopt* OR accept*) year oldest to 2022
Inclusion Criteria	Studies focusing on the adoption of blockchain technology in the field of SCM will be included
Exclusion Criteria	Technically focused studies that do not help answer the research problem will be excluded
Data Analysis and Synthesis	Variables identified as influential in the blockchain adoption process will be reported from the selected articles. The findings will be synthesized according to the study's objectives under the categories of "technological, organizational, environmental, individual, and innovation-specific variables," based on the TAM, UTAUT, TOE, and DOI theories.

Source: Created by Author

The primary criterion for selecting a database for a Systematic Literature Review (SLR) is the comprehensiveness of its content coverage. Web of Science (WoS) and Scopus are the two most widely used bibliographic databases (Pranckute, 2021; Singh et al., 2021). Pranckute (2021) describes these databases as the "giants of bibliographic information in today's academic world," emphasizing their extensive scope.

For over 40 years, Web of Science (formerly Web of Knowledge) held a monopoly as the sole database until the introduction of Scopus by Elsevier in 2004. Simultaneously, the Google Scholar (GS) database was also introduced. Unlike subscription-based databases such as WoS and Scopus, Google Scholar is freely accessible to all users and offers more general content coverage across disciplines, regions, countries, and languages (Pranckute, 2021). Despite the advantages of broad coverage and free access, Google Scholar was not selected for this dissertation due to concerns about its reliability in bibliometric studies, stemming from a lack of transparency and control.

The fact that Scopus provides broader overall coverage compared to WoS has been confirmed multiple times through both initial and recent content comparisons. Generally, the content indexed by WoS and Scopus overlaps significantly, but Scopus indexes a larger volume of unique sources not covered by WoS. Additionally, the coverage of both databases varies across different scientific disciplines. While both databases comprehensively cover engineering, medicine, and natural sciences, they are less comprehensive for social sciences and humanities. Furthermore, regional and national studies and non-English publications are not sufficiently covered in these databases (Pranckute, 2021; Singh et al., 2021). Despite expanding their coverage over time, both databases still struggle with these regional disparities. Both databases have inadequate representation in certain regions, languages, and fields (Asubiaro et al., 2024).

In this dissertation, Scopus is chosen as the search engine due to its extensive coverage and unique functionalities in the article reporting stage, compared to other academic databases such as Web of Science (Singh et al., 2021; Rejeb et al., 2021; Maflahi et al., 2016). Scopus indexes many publications, including Elsevier, Springer, IEEE (Institute of Electrical and Electronics Engineers), and more (Foncubierta-Rodríguez et al., 2014). Although it is known to contain fewer publications than Google Scholar, the high quality of the listed publications makes it a preferable choice. Moreover, Scopus features unique functionalities that significantly reduce the time and effort required to collect data. Data can be exported in various formats and with specific variables selected according to the output type chosen in Scopus, and all citations in selected articles can be accessed with just two clicks (Ke & Bronicki, 2015).

3.4.2. Conducting the SLR process

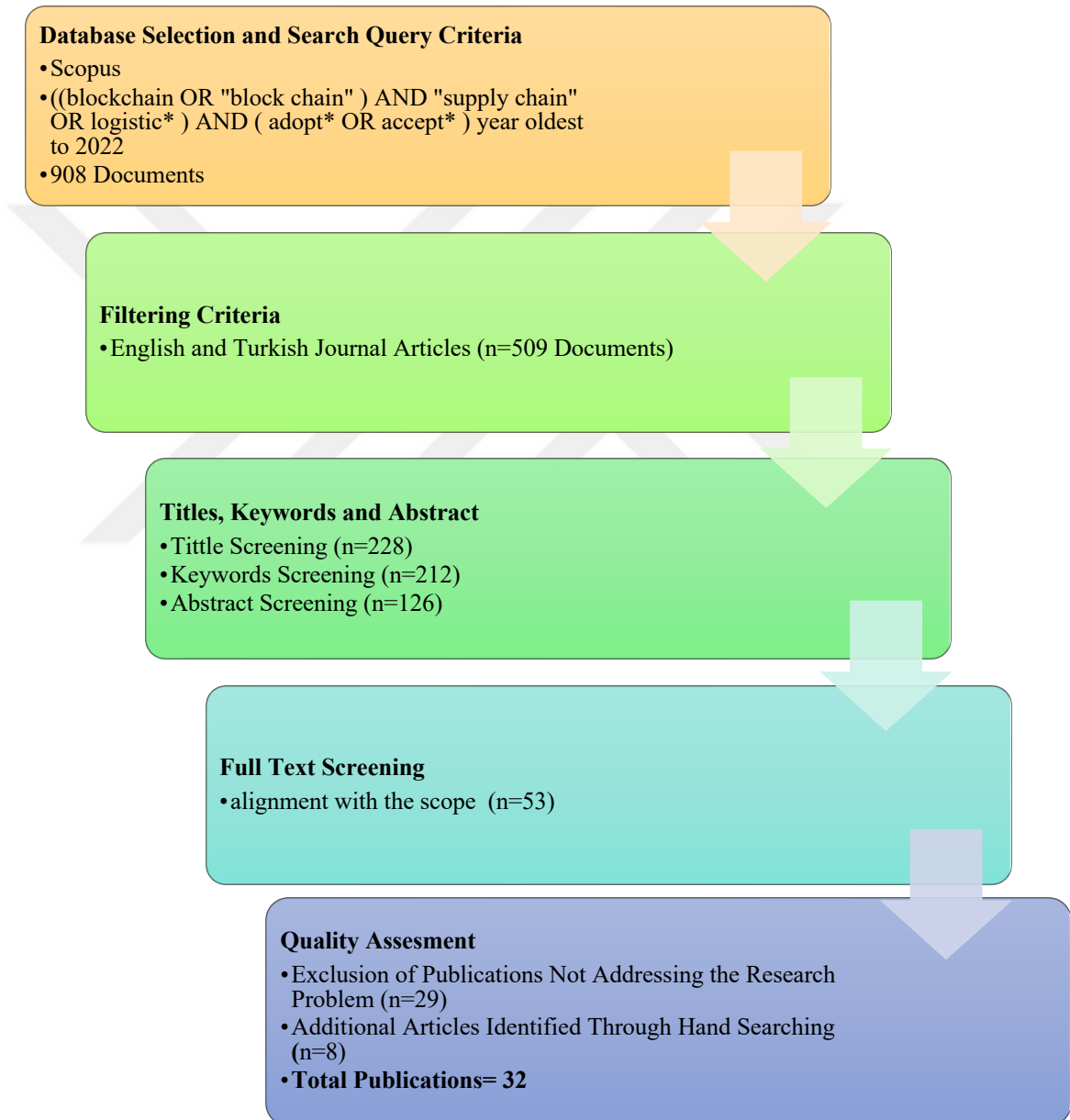
This phase encompasses the practical execution of the SLR and consists of five main steps. First, a search strategy is identified, where keywords and search terms for the review are defined. Second, during the study selection phase, potentially relevant studies are identified from the search results, and these studies are evaluated and selected based on inclusion and exclusion criteria. Third, the assessment of study quality takes place, where the methodological quality of the included studies is evaluated. This assessment focuses on the study's internal validity and relevance to the research questions. Fourth, in the data extraction and progress monitoring phase, data is systematically extracted from

the studies and documented. Finally, the extracted data is synthesized in the data synthesis phase, and key findings are summarized.

Figure 17 presents the selected online databases, types of publications, filtering criteria, and the data extraction and synthesis process to ensure transparency and traceability.

Figure 17

Systematic Literature Review (SLR) Screening Process



Source: Created by Author

3.4.3. Reporting of Critic Blockchain Adoption Factors in SCM

This section presents the findings from the systematic literature review, focusing on the critical factors influencing the adoption of blockchain technology in SCM . Through an

in-depth examination of 32 relevant articles, a total of 50 key factors were identified. It is important to note that while the literature may encompass a broader range of factors, the selection of these 50 factors in this study was preferred because of their clarity, comprehensiveness, and diversity.

Table 8 provides a categorized summary of the 50 critical factors identified through the systematic literature review. These factors were grouped into five major themes: Technological, Organizational, Environmental, Innovation-Specific, and Individual Factors. Each category aligns with established theoretical frameworks, including TOE, UTAUT, and DOI, to offer a structured understanding of the blockchain adoption landscape in SCM .

Table 8

Categorized Blockchain Adoption Factors Based on Theoretical Frameworks

Category	Theoretical Framework	# of Factors	Key Examples of Factors
Technological Factors	TOE	10	Scalability, Security Risks, Privacy Concerns
Organizational Factors	TOE	14	Organizational Culture, Financial Resources, Top Management Support
Environmental Factors	TOE	14	Regulatory Support, Industry Pressure, Market Dynamics
Innovation-Specific Factors	DOI	5	Relative Advantage, Complexity, Compatibility
Individual Factors	UTAUT	7	Trust in Technology, Perceived Benefits, Innovativeness

Source: Created by Author

Table 9, below presents the technological factors influencing blockchain adoption in SCM, identified through a SLT. These factors include both external and internal technological considerations, with their corresponding definitions and references detailed in the table.

Table 9*Technological Factors, Descriptions, and References*

Code	Technological Factors	Description	References
T1	<i>Technological Volatility</i>	<i>The rate of change in specifications or improvements in blockchain technology.</i>	Dehghani et al., 2022
T2	<i>Technological Immaturity</i>	<i>The relative newness of blockchain technology and its limited commercial applications.</i>	Rejeb et al., 2022; Kouhizadeh et al., 2021; Samad et al., 2023; Ghode et al., 2021; Akhtar et al., 2021;
T3	<i>Existing IT Infrastructure</i>	<i>The difficulty of replacing and/or adapting existing legacy systems for blockchain adoption.</i>	Gökalp et al., 2022; Akhtar et al., 2021; Bendarag et al., 2022; Choi et al., 2020; Orji et al., 2020; Noor, 2022; Park, 2022; Saberi et al., 2019
T4	<i>Scalability</i>	<i>The perceived ability of blockchain technology to handle increasing data volumes.</i>	Vafadarnikjoo et al. 2023; Samad et al., 2023; Heidary-Dahooie et al., 2022; Bendarag et al., 2022; Boutkhoul et al., 2021
T5	<i>Technology Characteristics: Trialability and Reversibility</i>	<i>The difficulty of trialing and reversing blockchain technology.</i>	Kouhizadeh et al., 2021
T6	<i>High Energy Consumption of Technology</i>	<i>The high energy costs required by blockchain technology.</i>	Rejeb et al., 2022; Samad et al., 2023; Boutkhoul et al., 2021
T7	<i>Technology Implementation Cost</i>	<i>The high implementation costs of blockchain technology and the uncertainty of return on investment.</i>	Samad et al., 2023; Mthimkulu and Jokonya, 2022; Akhtar et al., 2021; Bendarag et al., 2022; Choi et al., 2020; Boutkhoul et al., 2021; Çolak and Kağnicioglu, 2022; Orji et al., 2020
T8	<i>Privacy Concerns</i>	<i>Concerns about privacy and the risk of disclosing personal information in blockchain networks and transactions.</i>	Rejeb et al., 2022; Vafadarnikjoo et al. 2023; Bendarag et al., 2022; Choi et al., 2020; Orji et al., 2020
T9	<i>Security Risk</i>	<i>Concerns about the vulnerability of blockchain networks to attacks, cyber threats, and crypto theft.</i>	Rejeb et al., 2022; Mthimkulu and Jokonya, 2022; Kumar Bhardwaj et al., 2021; Choi et al., 2020; Kouhizadeh et al., 2021; Bendarag et al., 2022;
T10	<i>Usage in Informal Economies</i>	<i>The potential use of blockchain technology in illicit activities such as money laundering, gambling, and terrorism due to its unregulated nature.</i>	Rejeb et al. 2022; Vafadarnikjoo et al. 2023

Source: Created by Author

Table 10 lists the organizational factors influencing blockchain adoption, derived from a SLT. These factors encompass the internal resources, capabilities, and characteristics of organizations that may either facilitate or hinder the adoption process.

Table 10*Organizational Factors, Descriptions, and References*

Code	Technological Factors	Description	References
01	<i>Organizational Culture</i>	<i>The idea that the successful implementation of blockchain technology depends on a supportive organizational culture that encourages risk-taking.</i>	Rejeb et al. 2022; Bendarag et al., 2022; Boutkhoul et al., 2021; Orji et al., 2020
02	<i>Reluctance to Change/Resistance to Change</i>	<i>The reluctance to adopt new technology and change existing technologies.</i>	Rejeb et al. 2022; Kouhizadeh et al., 2022; Kouhizadeh et al., 2021; Bag et al., 2021; Balci and Balci, 2021; Boutkhoul et al., 2021; Noor, 2022; Saberi et al., 2019
03	<i>Organizational Readiness</i>	<i>The financial, technological, human resource, and knowledge capacity of an organization to implement and use technology.</i>	Shahzad et al. 2024; Tasnim et al., 2023; Lin et al., 2023; Agi and Jha, 2022; Mthimkulu and Jokonya, 2022; Clohessy and Acton, 2019
04	<i>Financial Resources</i>	<i>The lack of financial resources is a barrier to blockchain adoption, as it requires investment in advanced technology.</i>	Agi and Jha, 2022; Gökalp et al., 2022; Kouhizadeh et al., 2021; Wong et al., 2020; Choi et al., 2020; Akhtar et al., 2021; Bag et al., 2021; Balci and Balci, 2021; Deng et al., 2022; Saberi et al., 2019
05	<i>Technological Capabilities</i>	<i>The availability of advanced information systems and capabilities to collect, store, and transmit data necessary for blockchain adoption.</i>	Tasnim et al., 2023; Çolak and Kağnicioglu, 2022; Kumar Bhardwaj et al., 2021; Wong et al., 2020; Deng et al., 2022; Ruangkanjanases et al., 2022
06	<i>Lack of Expertise, Technical and Digital Knowledge</i>	<i>Insufficient knowledge about blockchain technology and its integration into the supply chain as a barrier to adoption.</i>	Agi and Jha, 2022; Clohessy and Acton, 2019; Choi et al., 2020; Rejeb et al., 2022; Dehghani et al., 2022; Kouhizadeh et al., 2021; Samad et al., 2023; Mthimkulu and Jokonya, 2022; Saberi et al., 2019
07	<i>Human Resource Adequacy</i>	<i>Constraints in skilled human resources and the costs of training as barriers to technology adoption.</i>	Bag et al., 2021; Boutkhoul et al., 2021; Orji et al., 2020
08	<i>Cost Concerns</i>	<i>High installation and maintenance costs of technology, uncertain return on investment, and insufficient funding as barriers to adoption.</i>	Samad et al., 2023; Mthimkulu and Jokonya, 2022; Kumar Bhardwaj et al., 2022
09	<i>Top Management Support</i>	<i>The allocation of sufficient human, financial, and infrastructural resources for effective implementation of blockchain technology.</i>	Clohessy and Acton, 2019; Tasnim et al., 2023; Gökalp et al., 2022; Orji et al., 2020; Kouhizadeh et al., 2021; Chittipaka et al., 2023; Deng et al., 2022; Kumar Bhardwaj et al., 2021; Wong et al., 2020; Nath et al., 2022; Choi et al., 2020; Bendarag et al., 2022; Samad et al., 2023; Boutkhoul et al., 2021 ;Saberi et al., 2019

Table Continued

O10	<i>Other Technology Priorities</i>	<i>Prioritizing other technology investments as a barrier to blockchain adoption.</i>	Clohessy and Acton, 2019
O11	<i>Technological Affinity at the Management Level</i>	<i>The management team's interest in blockchain technology as a facilitator for corporate-level adoption.</i>	Wong et al., 2020; Bag et al., 2021; Mthimkulu and Jokonya, 2022
O12	<i>Perceived Data Quality</i>	<i>Concerns about the accuracy of data entered into the blockchain.</i>	Dehghani et al., 2022
O13	<i>Trust in Technology</i>	<i>The subjective belief that blockchain has the potential to positively change current processes.</i>	Gökalp et al., 2022; Orji et al., 2020
O14	<i>Firm Size</i>	<i>The idea that larger firms are more likely to adopt new technology due to their greater risk management capabilities compared to smaller firms.</i>	Gökalp et al., 2022; Orji et al., 2020; Nath et al., 2022; Park, 2022; Clohessy and Acton, 2019

Source: Created by Author

Table 11 outlines the environmental factors influencing blockchain adoption, identified through a SLT. These factors consider external influences and resources that lie beyond an organization's control but significantly impact the adoption process.

Table 11

Environmental Factors, Descriptions, and References

Code	Technological Factors	Description	References
E1	<i>Regulatory Environment Uncertainty</i>	<i>The perceived uncertainty or lack of clarity regarding blockchain technology's legal and regulatory status.</i>	Dehghani et al., 2022; Kouhizadeh et al., 2021; Samad et al., 2023; Akhtar et al., 2021; Bag et al., 2021; Balci and Balci, 2021; Choi et al., 2020; Sivula et al., 2020; Park, 2022; Mthimkulu and Jokonya, 2022; Saberi et al., 2019
E2	<i>Regulatory Support</i>	<i>Policies and laws that encourage the adoption of blockchain technology.</i>	Lin et al., 2023; Chittipaka et al., 2023; Rejeb et al., 2022; Deng et al., 2022; Kumar Bhardwaj et al., 2021; Wong et al. 2020; Nath et al., 2022; Choi et al. 2020; Samad et al., 2023; Bendarag et al., 2022; Boutkhoul et al., 2021; Orji et al., 2020
E3	<i>Standardization Uncertainty</i>	<i>The perceived uncertainty regarding the existence and consistency of blockchain standards within or across industries.</i>	Dehghani et al., 2022; Gökalp et al., 2022; Samad et al., 2023; Heidary-Dahooie et al., 2022; Akhtar et al., 2021; Sivula et al., 2020

Table Continued

E4	<i>Trade Partner Pressure</i>	<i>The role of trade partners in encouraging blockchain adoption.</i>	Agi and Jha, 2022; Gökalp et al., 2022; Orji et al., 2020; Nath et al., 2022; Ruangkanjanases et al., 2022; Fosso Wamba et al., 2020; Clohessy and Acton, 2019
E5	<i>Vendor Support</i>	<i>The provision of security controls, user training, and technical support by vendors to successfully implement blockchain technology.</i>	Kumar Bhardwaj et al., 2021; Choi et al., 2020; Mthimkulu and Jokonya, 2022
E6	<i>Customer Interest</i>	<i>Customer interest in traceability information and other data related to products in the blockchain.</i>	Agi and Jha, 2022;
E7	<i>Industry Pressure</i>	<i>Industry-wide initiatives that promote the adoption and use of blockchain technology.</i>	Agi and Jha, 2022; Clohessy and Acton, 2019
E8	<i>Competitive Pressure</i>	<i>Internal pressure and the desire to gain a competitive advantage are motivators for adopting innovative technologies.</i>	Tasnim et al., 2023; Chittipaka et al. 2023; Deng et al., 2022; Gökalp et al., 2022; Agi and Jha, 2022; Wong et al. 2020; Wamba and Queiroz, 2020; Çolak and Kağnicioglu, 2022; Orji et al., 2020
E9	<i>Market Dynamics</i>	<i>The constantly changing environment in a highly competitive and complex market hinders blockchain adoption.</i>	Oguntegbe et al., 2022; Kouhizadeh et al., 2021; Bag et al., 2021; Park, 2022; Orji et al., 2020; Mthimkulu and Jokonya, 2022; Saberi et al., 2019; Clohessy and Acton, 2019
E10	<i>Information Sharing</i>	<i>Information sharing among supply chain members or within the industry as a facilitator for blockchain technology adoption.</i>	Kouhizadeh et al., 2021; Saberi et al., 2019
E11	<i>Lack of Successful Examples</i>	<i>The lack of successful examples related to blockchain technology is a deterrent to adoption.</i>	Vafadarnikjoo et al. 2023
E12	<i>Sustainability Issues</i>	<i>Environmental concerns due to the high electricity consumption of technology are a barrier to adoption.</i>	Kouhizadeh et al., 2021
E13	<i>Perceived Network Development</i>	<i>The belief is that the adopted technology can improve the quality of existing networks or create new ones as a facilitator for adoption.</i>	Dehghani et al., 2022; Bag et al., 2021 (stated collaboration)

Table Continued

E14	<i>Cultural Differences Among Supply Chain Partners</i>	<i>The cultural differences between supply chain actors and partners may hinder the acceptance of blockchain technology.</i>	Rejeb et al. 2022; Kouhizadeh et al., 2021; Bag et al., 2021; Saberi et al., 2019
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Source: Created by Author

Table 12 presents the innovation-specific factors influencing blockchain adoption, derived from a SLT. These factors pertain to the inherent characteristics and attributes of blockchain technology that directly affect its adoption and integration.

Table 12

Innovation-Specific Factors, Descriptions, and References

Code	Technological Factors	Description	References
INN01	<i>Relative Advantage</i>	<i>The degree to which blockchain technology is perceived as offering better benefits than existing technologies.</i>	Tasnim et al., 2023; Lin et al., 2023; Chittipaka et al. 2023; Gökalp et al. 2022; Agi and Jha, 2022; Kumar Bhardwaj et al., 2021; Wong et al., 2020; Mthimkulu and Jokonya, 2022; Çolak and Kağnicioglu, 2022; Deng et al., 2022;
INN02	<i>Complexity</i>	<i>The relative difficulty of understanding and using blockchain technology.</i>	Clohessy and Acton, 2019; Agi and Jha, 2022; Mthimkulu and Jokonya, 2022; Gökalp et al., 2022; Noor, 2022; Kumar Bhardwaj et al., 2021; Wong et al., 2020; Bendarag et al., 2022; Choi et al., 2020; Çolak and Kağnicioglu, 2022; Deng et al., 2022; Orji et al., 2020
INN03	<i>Compatibility</i>	<i>The alignment of the technology with the adopter's existing values, past experiences, and organizational culture.</i>	Gökalp et al., 2022; Clohessy and Acton, 2019; Chittipaka et al. 2023; Agi and Jha, 2022; Kumar Bhardwaj et al., 2021; Choi et al., 2020; Deng et al., 2022; Orji et al., 2020; Nath et al., 2022; Noor, 2022;
INN04	<i>Maturity</i>	<i>The immaturity of blockchain technology and its limited commercial application as a barrier to adoption.</i>	Akhtar et al., 2021; Bag et al., 2021; Choi et al., 2020; Sivula et al., 202; Saberi et al., 2019; Clohessy and Acton, 2019;
INN05	<i>Blockchain Transparency</i>	<i>The transparency, traceability, and verifiability of transactions conducted through blockchain as facilitators of adoption.</i>	Shahzad et al. 2024; Sharma et al., 2023; Fosso Wamba et al. 2020; Queiroz ve Fosso Wamba, 2019; Ghode et al., 2021; Çolak and Kağnicioglu, 2022; Nath et al., 2022

Source: Created by Author

Lastly, Table 13 presents the individual factors influencing blockchain adoption, identified through a SLT. These factors reflect personal attitudes, behaviors, and perceptions toward technology adoption at the individual level.

Table 13

Individual Factors, Descriptions, and References

Code	Technological Factors	Description	References
IND1	<i>Perceived Benefits of Technology</i>	<i>The belief that blockchain technology will improve job performance and efficiency as a facilitator of adoption.</i>	Clohessy and Acton, 2019; Wong et al. 2022; Kumar Bhardwaj et al., 2021; Queiroz et al., 2020; Mthimkulu and Jokonya, 2022; Kamble et al., 2019; Bag et al., 2021; Orji et al., 2020; Park, 2022
IND2	<i>Perceived Ease of Use / Effort Expectation</i>	<i>The degree of ease associated with using the system, including its simplicity and understandability.</i>	Park, 2022; Queiroz et al., 2020; Kumar Bhardwaj et al., 2021
IND3	<i>Trust in Technology</i>	<i>The belief that blockchain technology can effectively solve tasks and make processes easier, positively influencing its adoption.</i>	Lin., et al., 2023; Chittipaka et al. 2023; Wong et al. 2020; Queiroz et al., 2020; Balci and Balci, 2021; Nath et al., 2022; Queiroz et al., 2020
IND4	<i>Facilitating Conditions</i>	<i>The belief that the organizational and technical infrastructure exists to support the use of the system.</i>	Shahzad et al., 2023; Park, 2022; Queiroz et al., 2020
IND5	<i>Affinity for Technology</i>	<i>A person's tendency to actively engage with or avoid technology as a predictor of their readiness for technological adoption.</i>	Wong et al., 2020
IND6	<i>Social Impact</i>	<i>The degree to which an individual perceives that important others believe they should use the new system.</i>	Queiroz et al., 2020; Queiroz et al., 2020; Park, 2022
IND7	<i>Innovativeness</i>	<i>The tendency of a user to be a pioneer in the technology field.</i>	Shahzad et al., 2023

Source: Created by Author

The comprehensive reporting of these factors, presented across Tables 9 to 14, offers a clear and structured understanding of the critical elements influencing blockchain adoption within SCM, with each table focusing on a specific category of factors.

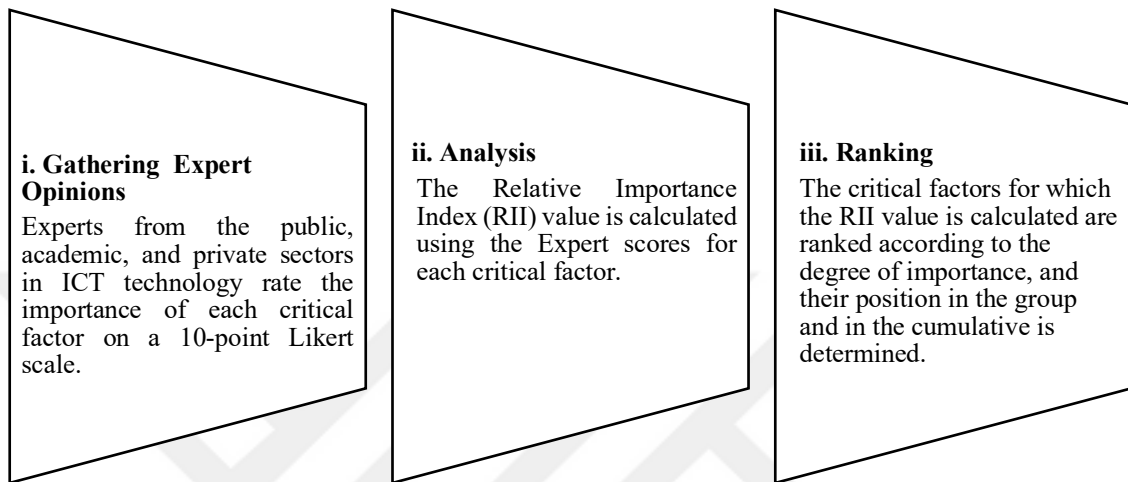
3.5. Stage 2- Quantitative Method: Ranking Analysis via Expert Survey

In line with the second research question and objective of the study, at this stage, Ranking Analysis is applied to determine the importance of each IT adoption variable in Türkiye in the categories of T, O, E, INNO and IND. The purpose of ranking analysis is to

prioritize critical adoption variables in order of importance. The ranking analysis is based on i. Expert opinion, ii. Analysis and iii. Ranking, which consists of three steps. These steps are shown in Figure 18 below.

Figure 18

Ranking Analysis Process



Source: Created by Author

This stage consists of conducting the feasibility study, preparing the expert opinion survey form, obtaining expert opinions and participant information, ranking analysis, and reporting the findings.

3.5.1. Gathering of Expert Opinion

“Expert Opinion” is the first step in the ranking analysis. The step is to collect expert scores for each critical factor using the questionnaire form. At this stage, experts were asked to evaluate each variable under five different categories, namely “Technological Factors”, “Organizational Factors”, “Environmental Factors”, “Individual Factors” and “Innovation Specific Factors” with their explanations in the context of Türkiye. The expert opinion method is suitable in the blockchain adoption literature for ranking influential factors (Ghode et al. 2020; Rejeb et al. 2022; Samad et al. (2023)). The number of experts required at this stage varies according to the literature. Ghode et al. (2020) took only 5 expert opinions from academia and industry to rank the 8 factors affecting blockchain adoption, which they identified from the literature review with gray relational analysis (GRA), one of the CRM techniques. Rejeb et al. (2022) collected data from 12 experts to rank the barriers to blockchain adoption in the circular economy using fuzzy

Delphi and Best Worst Method. Samad et al. (2023) applied DEMATEL technique with 12 expert opinions to determine the relationship between 13 blockchain adoption variables.

When the relevant literature on who can be the expert in this study is examined, it is generally understood that there is no requirement to have both blockchain and supply chain expertise at the same time, regardless of individual or institutional data (Agi & Jha, 2022; Kouhizadeh et al., 2021). In addition, blockchain technology does not need to be actively used, and the sample can consist of blockchain adopters, those who are considering adopting it, and those who have not yet adopted it (Dehghani et al., 2022)

Communication with the expert group was ensured through e-mail and networking via the LinkedIn platform.

3.5.1.1. Preparation of Expert Opinions Survey

While preparing the expert form, the findings of the Systematic Literature Review (SLR) were used to reveal the factors (inhibitors/incentives) that are effective in the adoption of Blockchain Technology in the supply chain.

The variables obtained from the literature as a result of the SLR review were grouped under five different categories, “Technological Factors,” “Organizational Factors,” “Environmental Factors,” “Individual Factors,” and “Innovation Specific Variables” and included in the expert form.

In the expert form, it is stated that this dissertation seeks answers to the questions “Which of the encouraging and hindering factors are important for the adoption of Blockchain technology in supply chains in Türkiye?”; “Which factors should be taken into consideration primarily in the adoption process of Blockchain technology in the context of the supply chain in Türkiye?”.

Before proceeding to the questionnaire, a one-page explanation text was included stating the subject, purpose, motivation of the dissertation, and the purpose of the expert opinion.

The experts were asked to evaluate each variable under five different categories, namely “Technological Factors”, “Institutional Factors”, “Environmental Factors”, “Individual Factors” and “Innovation Specific Variables” with their explanations in the context of

Türkiye and to score them using a scale of 1 (Not at all Important) to 10 (Very Important) according to their importance in the blockchain adoption process.

This scale has some important advantages. First of all, users and respondents are familiar with this scale. The 10-point Likert scale allows for more alternatives and differentiation in responses. It allows for further statistical analysis as there is more response variability (TLF Research, 2022). The expert opinion survey form is presented in Appendix 1.

3.5.1.2. Selection of Experts

Due to Türkiye's developing country profile, there is a possibility that experts with sufficient knowledge in the context of blockchain and supply chain may not be reached due to concerns that technology adoption will be later compared to developed countries. However, according to Dehghani et al. (2022), “it is sufficient for organizations to accept blockchain as a possibility, and the sample can consist of blockchain adopters, those who are considering adoption, and those who have not yet adopted it.

In addition, when the studies in the literature are evaluated in general, it is understood that there is no requirement to have both blockchain and supply chain expertise at the same time, regardless of individual or organizational data. In fact, in the study of Agi and Jha (2022), some of the 37 French experts were experts in supply chain and some were experts in Information Technologies. In the study of Kouhizadeh et al. (2021), 35 experts from academia and 12 experts from practice were studied.

In some studies, it was found that experts came from different sectors. For example; Vafadarnikjoo et al. (2023) selected 6 experts from automotive, chemical, cement, tile, telecom, and electronic manufacturing companies. Therefore, there was no need for any sector limitation.

In addition, according to existing studies, the experts' positions seem to vary. For example, the expert profile in the Agi et al. (2022) study is diverse, including the IT department, CEO, consultant, and SC managers.

An invitation text was sent to potential experts via LinkedIn and expert opinions were obtained in line with the statement of willingness to participate.

Since blockchain technology is a multidisciplinary field in terms of technology, finance, law and operations, the diversity of experts is important. Both the developer, implementer

and regulator sides of the technology are important in the diffusion of the technology. Therefore, it was planned to select domain experts from the private sector, public sector and academia who are stakeholders in blockchain projects that are currently being developed. In this process, the following steps were taken:

Since blockchain technology is a multidisciplinary field such as technology, finance, law and operations, the diversity of experts is of great importance. Developers, implementers and regulators all play a critical role in the proliferation of the technology. In this context, the expert selection strategy focused on stakeholders from the private sector, public sector and academia who are already actively involved in blockchain projects and represent sectoral diversity. The selection process was designed to represent various dimensions of blockchain adoption and included the following steps:

- Stakeholders from the “The Design of End-To-End Export Process (Within the Country) via Blockchain Technology” and speakers at sectoral, public, and academic consultation meetings were identified. This included experts from key institutions such as the Republic of Türkiye Ministry of Trade, Republic of Türkiye Ministry of Treasury and Finance, European Bank for Reconstruction and Development (EBRD), and ATEZ Software Technologies Inc..
- Board members of the Istanbul Blockchain Women Organization were selected. This non-profit organization aims to increase the presence and awareness of women in the blockchain ecosystem, providing valuable insights into gender-inclusive perspectives in the industry.
- The CEO and experts from TAGES were included. TAGES has been providing project management, consultancy, R&D, and innovation management services for SMEs, companies, NGOs, public institutions, and academia since 2002. Their expertise in ICT-based innovative blockchain applications made them a critical addition to the study.
- Relevant individuals from the Blockchain Türkiye Platform (BCTR) were identified. The platform plays a significant role in fostering the blockchain ecosystem in Türkiye.
- Blockchain experts from international auditing firms such as KPMG and EY were selected, offering a global perspective on blockchain adoption.

- Experts specializing in technology law were included to address the legal and regulatory aspects of blockchain implementation.
- A Supply Chain Manager from Daikin in the private sector was selected to provide a sector-specific perspective on blockchain's applicability in SCM.
- Academics specializing in decentralized finance (DeFi) and Web3 technologies, as well as an expert on blockchain-based payment systems in international trade, were included to provide insights into the economic and operational applications of the technology.

This strategic selection aimed to capture diverse perspectives and ensure a comprehensive analysis of the critical factors influencing blockchain adoption in Türkiye, leveraging insights from different sectors and areas of expertise.

3.5.1.3. Participants

The participants in this study are experts who offer different perspectives on the adoption of blockchain technology in SCM. The experts are grouped into three main profiles: *Private Sector Professionals & Practitioners*, *Academics*, and *“Policymakers & Practitioners (Public Institutions & Non-profit Organizations)”*.

Private Sector Professionals and Practitioners operate in various sectors, such as information technology, consulting services, finance, logistics, and manufacturing. Experts in this group have experience ranging from 14 to 34 years and often hold positions such as senior manager, consultant, financial expert, CIO, and COO. The broad industry experience of these experts is valuable for the research.

Academics are individuals with various academic titles and specializations in SCM, information technology, law, finance, and logistics. With experience ranging from 10 to 28 years, this group offers theoretical knowledge and a research-oriented perspective. Academics are able to deeply analyze the theoretical foundations of blockchain technology and how it can be applied in SCM.

Policymakers and practitioners with experience ranging from 1 to 14 years, this group evaluates the adoption of blockchain technology in SCM from regulatory perspectives and public policies. Public sector experts analyze the role and potential impact of blockchain technology within legal and regulatory frameworks.

In conclusion, the different experiences and knowledge of experts play a key role in assessing the importance of critical factors for the adoption of blockchain technology in SCM. Each expert profile allows for detailed analysis from their perspective. Table 14 provides a summary of information about the experts.

Table 14

Experts Information

<i>Private Sector Professionals & Practitioners</i>			
<i>Expert (E)</i>	<i>Years of Experience</i>	<i>Position</i>	<i>Sector</i>
<i>E5</i>	34	Vice Chairman of the Board	Information Technology
<i>E25</i>	34	Consultant	Consulting Services
<i>E1</i>	33	Consultant	Consulting Services
<i>E12</i>	33	Financial Specialist	Consulting Services
<i>E11</i>	32	General Manager	Information Technology
<i>E7</i>	25	Consultant	Finance
<i>E6</i>	22	Consultant	Consulting Services
<i>E14</i>	22	Consultant	Consulting Services
<i>E4</i>	20	Operations Manager	Logistics
<i>E9</i>	20	CIO - Chief Information Officer	Information Technology
<i>E23</i>	20	Supply Chain Manager	Manufacturing
<i>E24</i>	20	CMO - Chief Marketing Officer	Information Technology
<i>E20</i>	18	Lawyer	Law
<i>E26</i>	18	CEO - Chief Executive Officer	Information Technology
<i>E27</i>	18	COO - Chief Operating Officer	Logistics
<i>E18</i>	17	Policy Expert	International Development
<i>E8</i>	15	Senior Manager	Finance
<i>E19</i>	14	IT Specialist	Logistics
<i>Academics</i>			
<i>Expert</i>	<i>Years of Experience</i>	<i>Academic Title</i>	<i>Specialization</i>
<i>E22</i>	28	Professor	SCM, International Trade, Finance, Logistics
<i>E21</i>	22	Assistant Professor	Law
<i>E2</i>	21	Assistant Professor	Information Technology, Management Sciences
<i>E15</i>	15	Associate Professor	Law
<i>E28</i>	15	Research Assistant	SCM, International Trade, Financial Technology
<i>E29</i>	13	Associate Professor	SCM, Information Technology, Production and Operations Management, Logistics
<i>E30</i>	13	Associate Professor	SCM, Production and Operations Management, Logistics
<i>E10</i>	10	Assistant Professor	Information Technology

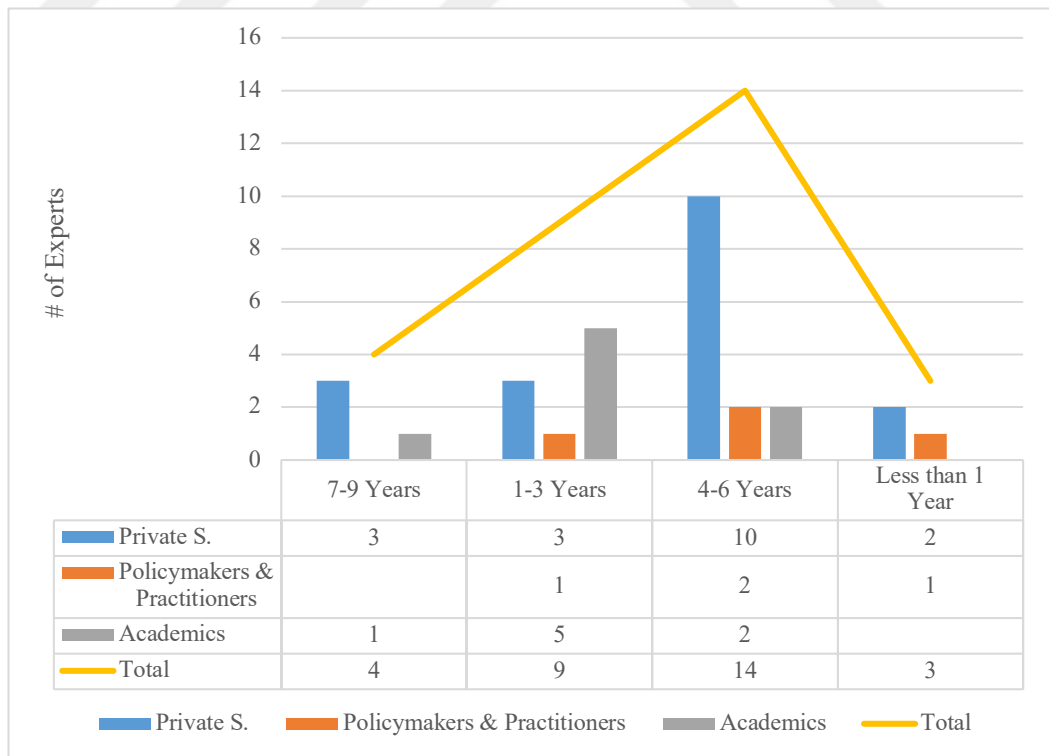
<i>Table Continued</i>			
<i>Policymakers & Practitioners (Public Institutions & Non-profit Organizations)</i>			
<i>Expert</i>	Years of Experience	Position	Institution
<i>E16</i>	14	Expert	Republic of Türkiye Ministry of Trade
<i>E3</i>	12	Expert	Republic of Türkiye Ministry of Trade
<i>E13</i>	8	Manager	Supply Chain, Logistics
<i>E17</i>	1	Assistant Expert	Republic of Türkiye Ministry of Trade

Source: Created by Author

Figure 19 below reveals that the length of experience with blockchain technology differs across expert groups. Most private sector experts (10 people) have 4-6 years of experience, while academics generally have 1-3 years of experience. Policymakers & Practitioners are mainly represented with 4-6 years of experience. Our data indicates that the private sector is leading the adoption of blockchain technology.

Figure 19

Years of Experience with Blockchain

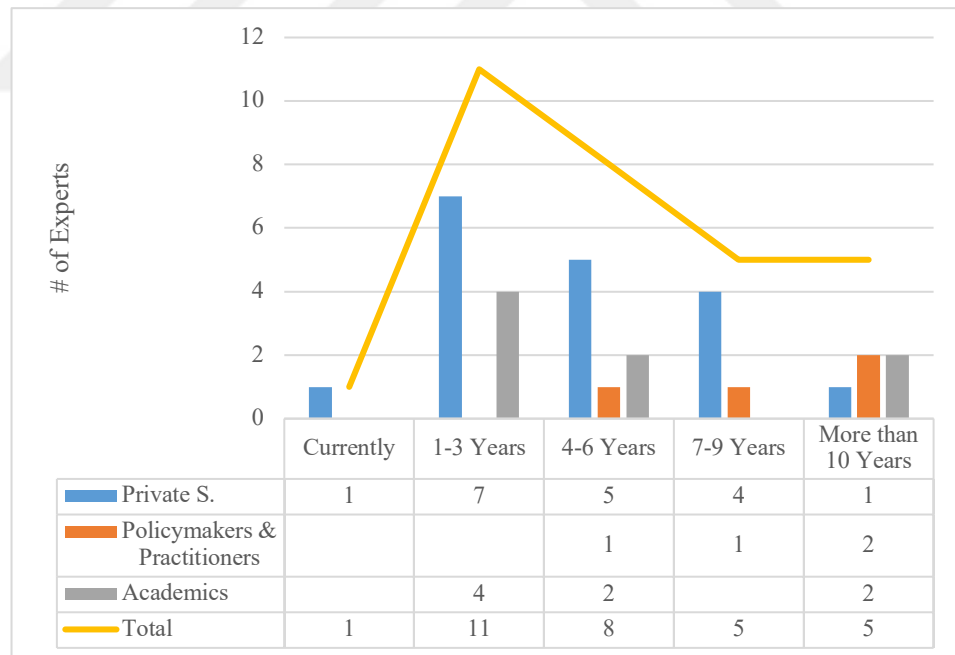


Source: Created by Author

The distribution of the expected years for the adoption of blockchain technology in SCM across expert groups is shown in Figure 20. According to the graph, the projected time to adoption of blockchain technology in SCM varies across expert groups. There is only 1 private sector professional who has already adopted blockchain technology. The majority expect blockchain technology to be adopted in 1-3 years, a prediction shared by 7 experts in the private sector, 4 in academia and 1 in the public sector. Those expecting adoption in 4-6 years are 5 experts in the private sector, 2 in academia and 1 in the public sector. Among those who foresee the adoption of blockchain technology in 7-9 years, there are 4 experts in the private sector, 1 in academia and 1 in the public sector. Finally, those who think that the adoption of blockchain technology will take longer than 10 years are 1 expert in the private sector, 2 experts in academia and 2 experts in the public sector. This data shows that the private sector expects a faster adoption process, while the academic and public sectors adopt a longer-term approach.

Figure 20

Expected Years for Blockchain Adoption in SCM



Source: Created by Author

3.5.2. Analysis

The analysis is the second step of the ranking analysis. In this step, the Relative importance index (RII) value of each variable is calculated.

RII is a suitable method for the first purpose. It allows each criterion to be compared with the others and the criteria to be ranked according to their importance.

The method is generally applied as follows. Criteria on a specific topic are identified from a comprehensive literature review, and these criteria are usually categorized into certain categories. Then, data is collected from experts through a questionnaire on the importance of the criteria under each category. Here, the Likert scale is usually used to measure the attitudes of the person. The Likert scale allows an individual to express how much he/she agrees or disagrees with a particular statement. Experts assign an importance score to each criterion using the Likert scale, and the score value of the criteria is determined. The weighted average calculated for each factor is then divided by the upper measurement scale to obtain an importance index (Fares & Mamine, 2023). The value of the RII is calculated using Equation (3.1)

$$RII = \frac{(\sum_{i=1}^n W_i n_i)}{A * N} \quad (3.1)$$

Where “ W_i ” is the weight given to each criterion by the respondent. “ i ” varies according to the score scale of the Likert scale. “ n_i ” is the number of respondents who gave as many points as W_i and is the frequency of responses. is the range that respondents give to each factor. “ A ” represents the highest score on the scale and “ N ” represents the total number of participants. In a study using a 5-point Likert scale, i ranges from 1 to 5 and A equals the highest score of 5.

The RII value ranges between 0 and 1, with 0 not included. The higher the RII value, the more important the criterion is. Existing studies have used different threshold values when comparing the level of importance (high-moderate-low) according to the RII value. For example, Aghili et al. (2019) classified the RII as high (H) ($0.8 \leq RII \leq 1$), medium (M) ($0.5 \leq RII \leq 0.8$), and low (L) ($0 \leq RII \leq 0.5$) according to the level of importance. Fares and Mamine (2023) used three levels of importance: High: $0.7 < RII \leq 1.0$; Medium: $0.4 < RII \leq 0.7$; Low (L): $0 < RII \leq 0.4$. Waris et al. (2014) used Chen et al. (2010) transformation matrix to define five levels of importance: extremely important, very important, neutral, less important, and not important at all. Chen et al. (2010) propose the transformation of High $0.8 < GME \leq 1.0$; High-Medium $0.6 < GME \leq 0.8$; Medium $0.4 < GME \leq 0.6$; Medium-Low $0.2 < GME \leq 0.4$; Low $< GME \leq 0.2$ for GME. This dissertation is based on the approach of Chen et al. (2010).

In the literature, Aghili et al. (2019) used this technique to measure and rank the relative importance of critical factors and categories in green building management in Malaysia. In the study, category RIIs were also calculated by averaging the RIIs of the criteria in each category. Murugan and Marisamynathan (2022) used this method to prioritise the factors preventing the adoption of electric vehicles in India from the customers' perspective. In another study, Othman and Khallaf (2022) used RII to provide a comprehensive understanding of the key barriers and success factors of renewable energy projects around the world. This study analyzed the barriers and critical success factors identified from the literature with survey data collected from 60 experts on a 5-point Likert scale. Their detailed analysis of different continents and sectors (public/private) found that the results varied. In a recent study, Fares and Mamine (2023) used this method to compare barriers and incentives to the adoption of wheat and pea cropping systems.

3.5.3. Ranking

“Ranking” is the last step in the ranking analysis. According to the RII value calculated in this step, cumulative (Cum. Rank) and in-group ranked values under each T, O, E, INNO, and IND category are reported. Thus, the critical factor ranking for Türkiye was made. Also, following Chen et al. (2010), the factors were grouped into high, high-medium, medium, medium-low and low importance levels according to the RII value.

The findings of the ranking analysis in this section are discussed and evaluated in detail in the results and discussion section.

3.6. Stage 3- Qualitative Method: Focused Analysis of Interviews

In the third stage of this dissertation, a basic qualitative research design was used, which allowed for an in-depth analysis of the interview data. This design is particularly suitable for uncovering key themes and patterns related to the adoption of blockchain technology in SCM. The basic qualitative research design allows for a flexible approach to the research process without strict adherence to a specific theoretical framework. This gives the researcher the freedom to choose the data collection and analysis strategies that best suit the purpose and nature of the study (Caelli et al., 2003; Kahlke, 2014).

Merriam and Tisdell (2016) defines this approach as “basic qualitative” or “interpretive” and states that this method can be used alone as an approach expressed by the researcher. As Percy et al. (2015) point out, traditional research designs (phenomenology,

ethnography, grounded theory, etc.) may not always be sufficient to examine the subjective thoughts, attitudes and experiences of participants. In such cases, researchers need more generic qualitative inquiry approaches. The basic qualitative research design responds to this need in a flexible way and adheres to the general principles of qualitative research, making it easier to adapt to the uncertainties that may be encountered in data collection, analysis and interpretation of findings.

In this context, a basic qualitative research design was considered suitable for examining the contextual and perceptual dynamics, identifying new factors, and exploring strategies to address barriers to the adoption of blockchain technology in Türkiye's SCM.

Before providing the details of the qualitative research process in this section, it was explained under the heading "Transition from Quantitative to Qualitative" that the third phase of the study was built on the findings obtained in the second phase. The results of the expert opinion survey conducted in the quantitative phase formed the basis of the qualitative interview process and it was aimed to examine the qualitative data in depth in line with these findings.

3.6.1. Transition from Quantitative to Qualitative Stage

In this study, before proceeding to the third stage, the participants were explained that the interview phase was decided to be conducted based on the findings of the expert opinion survey conducted in the previous quantitative phase. The participants were presented with the findings of the survey and were asked to share their assessments of the ranking of the importance of the factors and to comment on the accuracy and validity of this ranking in the Turkish context. As a result of the evaluations, it was determined that there was no contradiction in the ranking of the most important and least important factors. Accordingly, the interview process was initiated with the aim of obtaining more in-depth contextual data.

In the interview phase, the barriers to the adoption of blockchain technology in Türkiye and strategies to overcome these barriers were examined in detail. The main objective of this phase was to provide an in-depth understanding of contextual and perceptual dynamics by seeking an answer to the third research question (RQ3), to supplement the quantitative findings with qualitative data and to identify new factors specific to the Turkish context.

To this end, during the interviews, detailed information was collected from the participants about their perceptions of the blockchain adoption process, the challenges they face and their potential solutions. Thus, the quantitative findings of the previous phase were analyzed from a more in-depth and contextual perspective through qualitative analysis. The results obtained in the quantitative phase were supported and elaborated through qualitative findings and more comprehensive answers to the research questions were found.

The details of the qualitative research process are discussed in detail in the following sections.

3.6.2. Data Collection through Semi-Structured Interviews

The basic qualitative research design makes it possible to use various data collection methods (interview, observation, document analysis, etc.) together depending on the purpose of the study. In data analysis, the focus is on identifying recurrent patterns and themes are created based on these patterns. These themes play a key role in structuring and interpreting the findings of the research (Merriam, 2016).

Interviews are known as a good way to access people's perceptions, meanings, definitions and constructions of social reality (Punch, 2011). Since the aim to be achieved at this stage is “Exploration of the contextual and perceptual dynamics influencing blockchain adoption in Türkiye's SCM, along with the identification of new factors contributing to the adoption process through qualitative analysis.”, interviews are an appropriate data collection technique. Interviews are categorized as structured, semi-structured and unstructured. Here, the semi-structured type of interview was preferred, which does not follow as rigid procedures as the structured type, but allows for a more flexible data collection process and allows for an understanding of the participants' perspectives and inner world. In this type of interview, the researcher does not have to adhere to the order and boundaries of questions, although the researcher refers to the interview guide with a list of questions to be asked to the participants. If needed, the researcher can also ask new questions to the participants in order to better access the participant responses, where he/she basically adheres to the guide. In addition, in this type of interview, more information can be obtained with probing questions. Probe questions are questions and comments that follow questions and are usually randomly generated during the conversation (Merriam, 2016; Karakiraz, 2021)

The semi-structured interview technique is a frequently used approach in the literature to explore the factors affecting blockchain adoption (Clohessy & Acton 2019; Werner et al., 2021; Treiblmaier et al. 2021, Dehghani et al., 2022). In qualitative studies, reaching the theoretical saturation level is essential in deciding the number of interviewees (Gentles et al. 2015). Treiblmaier et al. (2021) conducted 10 interviews with executives involved in blockchain-based projects from established (6) and startup (4) companies, respectively, until a theoretical saturation level was reached and more resources and capabilities emerged. Werner et al. (2021) conducted semi-structured interviews with 10 people while investigating the impact of blockchain technology on a firm's potential competitive performance with a mixed method. Dehghani et al. (2022) interviewed 25 people to determine blockchain adoption factors. In this dissertation, interviews were conducted with 12 people in total. Details about the interviewees are given in the participants section.

3.6.3. Preparation of Interview Questions

The interview questions in the study were developed based on Dehghani (2022) and in line with the researcher's expertise. These questions aim to obtain in-depth information on the process of adoption of blockchain technology in SCM. In the semi-structured interview technique, it is recommended to use an interview guide to guide the researcher (Merriam, 2016). The interview guide serves as a checklist for the researcher, ensuring that the interviews follow a certain structure. At the same time, it allows the participants' unique views and experiences to emerge.

In this dissertation, an interview guide including the topics to be addressed during the interview process was prepared. The guide ensures that the research proceeds in line with the set objectives and that all necessary information is obtained. Moreover, the flexible nature of the guide allows the researcher to pose new questions to focus more deeply on participant responses. The interview guide is presented in Appendix 2.

3.6.4. Participants

In this dissertation, a purposive sampling technique was used to select individuals with in-depth knowledge and experience in blockchain technology and SCM. Purposive sampling was chosen to target participants who can provide a rich knowledge base and valuable insights on the research topic. This method, which is frequently used in qualitative research, allows for in-depth examination of information-rich situations and

enables the deliberate selection of participants who will directly contribute to the research questions without concern for statistical generalization (Neuman, 2012; Patton, 2014; Yıldırım & Şimşek, 2013; Creswell, 2014; Merriam, 2016).

Participants were selected based on specific criteria such as their position in the sector, length of professional experience and their contribution to blockchain technology. Participants were selected from senior executives, consultants, academics and technical leaders with expertise in areas such as blockchain technology, SCM, innovation, compliance and audit services. This diversity provided a broad perspective to assess the applications and impacts of blockchain technology in various sectors.

The work experience of the participants ranged from a minimum of 10 years to 34 years. This long-term experience has enabled them to have in-depth knowledge and understanding of blockchain technology and SCM. Participants come from different sectors such as government consulting, global consulting firms, software development, banking, logistics and NGOs. This diversity of sectors is critical to better understand the different application areas and challenges of blockchain technology.

Table 15 below provides information on participant profiles, years of experience and the interview process. All interviews were conducted online and some interviews were not recorded at the request of the participants. This indicates that the participants' privacy and wishes were respected.

Table 15

Comprehensive Overview of Participant Profiles and Interview Details

<i>Participants</i>	<i>Gender</i>	<i>Position</i>	<i>Years of Experience</i>	<i>Interview Channel</i>	<i>interview duration</i>
P1	M	Vice Chairman at a Research and Innovation Consulting firm	34	Online	01:12:16
P2	W	Senior manager on Blockchain, Compliance and Audit Services at a global consulting firm	20	Online	00:35:46
P3	M	Advisor to the Government	13	Online	00:27:08
P4	W	Vice Chairman at a Research and Innovation Consulting firm and Advisor to a NGO on Blockchain	34	Online	00:56:36 not recorded due to participant request
P5	W	Blockchain Lead Developer at a software company specialized in international supply chain		Online	

Table Continued

					not recorded due to participant request
P6	M	General Manager of a Logistics sector NGO	10	Online	
P7	M	Supply chain manager	20	Online	00:10:58
P8	W	Faculty, Member of BoD at a NGO on Blockchain	22	Online	00:31:08
P9	W	Associate Banker, Policy & Government Relations in a development bank	18	Online	00:15:46
P10	W	Product Manager/ Founding Member at a NGO on Blockchain	15	Online	not recorded due to participant request
P11	W	Co. Managing Partner at company specialized on Tech. Regulations	18	Online	00:25:48
P12	M	Member of Advisory board at Blockchain initiative in Türkiye and founder of a company specialized on Innovative ecosystems	22	Online	00:31:30

Source: Created by Author

3.6.5. Focused Analysis of Qualitative Interviews

The data of this study were analyzed using the “Focused Analysis of Qualitative Interviews” technique (Rädiker & Kuckartz, 2020). This analysis technique provides a systematic and structured examination of the data obtained from the interviews. MAXQDA, one of the computer-assisted qualitative data analysis programs, was used in the analysis process. MAXQDA is a powerful tool that facilitates data analysis in qualitative and mixed methods research. The main reason for choosing this technique is that it provides in-depth analysis of the data while at the same time reducing complexity and making the results more understandable and generalizable.

The “Focused Analysis of Qualitative Interviews” method was inspired by various qualitative data analysis methods. Mainly, qualitative content analysis developed by Kuckartz (2014) and computer-assisted qualitative data analysis methods described by Kuckartz and Rädiker (2019) are the main components of this method. In addition, qualitative content analysis studies by researchers such as Mayring (2014) and Schreier (2017) have made important contributions to this method. Applied thematic analysis (Guest et al., 2012), Grounded Theory (Bryant & Charmaz, 2011; Corbin & Strauss,

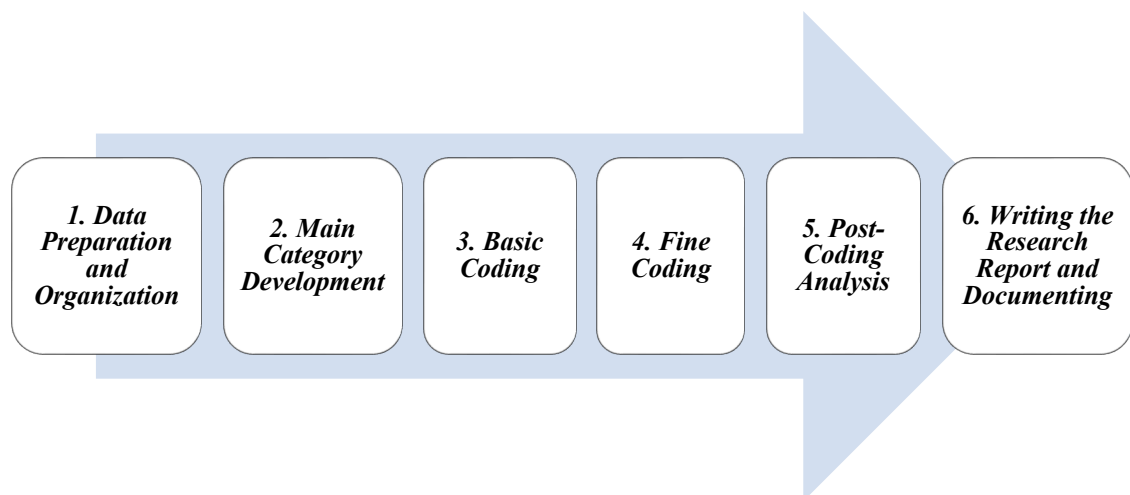
2015) and Saldaña's (2015) work on coding and category development are other important elements that support the methodological basis of this method. Finally, Bazeley (2013) and Creswell's (2014) practical approaches to qualitative data analysis and visualization have contributed to the development of this method.

Flick (2013) distinguishes two main strategies for analyzing qualitative data: The first one aims to summarize data and reduce complexity; according to Flick, the most important methodological step here is the coding of data (Flick, 2013) This strategy forms the basis of the “Focused Analysis of Qualitative Interviews” method. The second strategy adopts a more interpretive approach, sometimes working with very extensive or several competing interpretations, and tends to expand rather than reduce the data. The strategy adopted in this study, however, aims to analyze the data in a systematic way, focusing on the research questions, and to draw generalizable conclusions.

“Focused Analysis of Qualitative Interviews” consists of six basic steps as seen Figure 21. The systematic nature of this method helps researchers to analyze data in depth, reduce complexity and ensure that the findings are generalizable. With the support of advanced software such as MAXQDA, this method of analysis allows qualitative research to be conducted in a powerful and reliable way.

Figure 21

Six Steps of Focused Analysis of Interviews



Source: Created by Author

3.6.5.1. Data Preparation and Organization

This is the first stage where the data is prepared for analysis. As Rädiker and Kuckartz (2020) state, at this stage, the interview transcripts are systematically organized and the

researcher aims to become familiar with the interview content. For this reason, the audio recordings of the interviews were first transcribed. The notes obtained from the participant interviews that did not allow audio recording were prepared in a similar way. At the transcription stage, a separate text file was created for each interview transcription in line with the recommendations of Kuckartz and Rädiker (2019). Therefore, 12 transcription files were obtained from 12 interviews and made ready for analysis in the Maxqda program.

3.6.5.2. Main Category Development

At this stage, the main categories that will form the basis for the basic coding process are determined by considering the interview guide. In Table 16, the main categories and category definitions identified for this study are presented in relation to the questions in the interview guide. In addition, the category of “other” was added so that elements that are important for the research question but do not fit into the existing categories that may be encountered during the review of the transcripts can also be taken into account in the analysis.

Table 16

Main Categories, Interview Questions, and Descriptions

Main Categories	Interview Questions	Category Descriptions
Barriers to Blockchain Adoption in SCM	1. In your opinion, to what extent are organizations in Türkiye ready to adopt blockchain technology in SCM? (Would you say there is significant interest?) 2. What are the critical barriers to the implementation of blockchain in SCM in Türkiye? 3. How important are factors like the complexity of blockchain, its immature state as a technology, and high energy costs?	This category covers the barriers encountered during the blockchain adoption process in SCM, and how these barriers impact the adoption process.

Table Continued

Solution Proposals	4. In your opinion, what resources can organizations use to overcome internal and inter-organizational barriers to blockchain adoption? What are your recommendations? 5. What changes are necessary to increase the adoption of blockchain technology in SCM? Consider this from organizational policies, government policies, and technical perspectives.	This category includes strategies and recommendations to overcome barriers in the adoption of blockchain technology in SCM.
Others		This category is used for responses that are important but do not clearly fit into any of the established categories yet.

Source: Created by Author

3.6.5.3. Basic Coding

The basic coding stage refers to the categorization of the interview data according to predetermined main categories. In this process, the statements in the interview transcripts are evaluated in terms of whether they fit the relevant category definitions, and those that do are assigned to specific categories. Basic coding involves simply deciding whether participant statements fall within the categories identified, without any in-depth analysis. At this stage, coding is done in strict adherence to category definitions, and category definitions can be further refined if necessary. Care is taken to ensure that the coded sections are also understandable in the sensitive coding process to be carried out in the future. For this reason, one-word codes that are difficult to understand should be avoided.

Table 17 below shows the main categories made during the basic coding phase and examples representing these categories.

Table 17

Main Categories and Representative Quotes from Basic Coding

Main Categories	Example Quotes from the Data for the Main Category
Barriers to Blockchain Adoption in SCM	"How can I put this, I'm not just talking about the lack of technical knowledge. People don't have enough knowledge about the subject, so there are many prejudices. They are aware that it is a technical thing, but there is a significant lack of understanding among those who don't make an effort to grasp its logic, vision, and working principles. This negatively affects both trust and adoption." (P8)

Table Continued

Recommendations and Strategies	"Government intervention, regulatory adjustments, partial transitions are required. After this process, blockchain will be used in logistics; the perception will change if supportive regulations emerge within the legal framework that makes blockchain possible. When it is optional, the allocation of resources to this technology might remain hesitant. Determining its effects and usage within a regulatory framework will be a key factor." (P6)
Expectations Regarding Blockchain	"I think blockchain will achieve significant things in more specific areas. However, it won't be as influential in every sector and field as artificial intelligence is right now. Blockchain might be more effective in digital identity processes. It can also be used in payment and finance areas; for example, in p2p (peer-to-peer) transactions." (P3)

Source: Created by Author

Rädiker and Kuckartz (2020) stated that in order to check inter-coder agreement, when a second coder is not available, the researcher can improve coding quality by repeating the same process two weeks after the first basic coding. In this dissertation study, since it was not possible to work with a second coder who is familiar with the subject of the dissertation on blockchain technology and supply chain, the same coding process was repeated 15 days after the first coding, and it was determined that the agreement between the two codings was quite high.

3.6.5.4. Fine Coding

In the Fine Coding phase, the categories obtained through basic coding were systematically reviewed and the category system was expanded by creating new subcategories if necessary.

Participant statements were re-read and important elements were noted, and new subcategories were derived from these statements. Then, the statements under the main categories and subcategories were re-evaluated with sensitive coding.

When necessary, second level subcategories were created and the coding process was repeated for these subcategories, resulting in the final version of the category system. Table 18 illustrates how the category system was developed.

Table 18*Example of Category System Development and Fine Coding*

<i>Main Category</i>	<i>Sub-Category</i>	<i>Second Order Sub-Category</i>
Barriers to Blockchain Adoption in SCM	Cognitive and Attitudinal Barriers Related to Blockchain Technology	Lack of Knowledge and Awareness
		Blockchain Mindset
		Trust in Blockchain
		Unrecognized Need for Blockchain Technology Prejudice and Negative Perception

Source: Created by Author

3.6.5.5. Post-Coding Analysis

Our aim at this stage was stated as “To explore the barriers hindering blockchain adoption and propose strategies to facilitate its integration within Türkiye's SCM sector”. In line with the research objective, “topic/category-oriented analyses” focusing on coded text sections rather than individuals or cases were preferred.

In the study, coded texts with categories and subcategories were compiled and analyzed. In this process, the most appropriate quotations were included in the text to reflect the category contents. During the analysis, the frequency of participant statements was determined using MAXQDA software. In addition, data visualization techniques were used to present the relationships between categories and subcategories to the reader. With MAXQDA's MAXMaps function, each main category and subcategory was presented as a Hierarchical Category-Subcategory Model, categories and subcategories were visualized on the basis of participants' statements. In this way, a general view of the categories and an understanding of the relationships were provided.

3.6.5.6. Writing the Research Report and Documenting

This is the stage where the research findings are presented, the research process is documented and the research report is written. All findings from the Focused Analysis of Qualitative Interviews are presented and interpreted in the Results and Discussion section under the title Results of Qualitative Method: Focused Analysis of Interviews. In order to present the findings in a more comprehensible way, various tables and graphs were added in the relevant section using MAXQDA's data visualization features.

3.6.6. Trustworthiness

The concepts of validity and reliability in qualitative research require a different approach from quantitative research. In this context, Guba and Lincoln (1982) introduced the concept of trustworthiness and stated that qualitative research should be evaluated on four basic criteria: credibility, dependability, confirmability and transferability. In this study, a systematic and transparent process was followed in line with each criterion to ensure credibility.

First, the Credibility criterion relates to the degree to which the research provides a true picture of the phenomenon under investigation. In order to ensure credibility, methods such as prolonged involvement, member checking and peer debriefing have been proposed in the literature (Holloway & Wheeler, 1996; Creswell, 2014; Başkale, 2016). In this direction, during the thesis, long-term interaction with the participants was carried out and the interviews were planned in accordance with their professional lives. The interviews were conducted and recorded on the Zoom platform and then transcribed. Attention was paid to the interview environment in order for the participants to feel comfortable, which created an environment of trust and enabled in-depth data to be obtained. The findings were presented to the participants after the interviews and their accuracy was confirmed. In this process, some arrangements were made in line with the opinions and contributions of the participants and the accuracy of the data was increased (Yıldırım & Şimşek, 2013; Merriam, 2016). In addition, the thesis advisor and two independent academics were consulted during the coding and analysis processes. The codes were revised and necessary arrangements were made in line with the suggestions of the academics. This process supported reliability within the scope of peer debriefing strategy in qualitative research.

Secondly, in line with the Reliability criterion, a triangulation strategy is generally recommended to ensure the internal validity of the study (Başkale, 2016). In this thesis, critical factors were identified from the literature for blockchain adoption with SLT before proceeding to the qualitative research phase, and then critical factors were ranked according to their relative importance level by taking expert opinion in the quantitative research part. These stages enabled the qualitative research findings to be compared with the previous findings. In this way, the triangulation of methods as document analysis,

prioritization with expert opinion and interviews supported reliability. In addition, repeated checks during coding supported reliability.

Third, Confirmability refers to minimizing the subjectivity of the researcher and basing the findings on participant data. Başkale (2016) recommends recording the raw data (audio recordings, field notes), presenting the analyzed data, explaining the formation of the findings (codes, themes), describing the study process in detail, and clarifying the objectives and methods of the study. Accordingly, all interview recordings and transcripts were systematically archived and the analysis process was supported by direct quotations from the participants. Direct quotations strengthen the objectivity of the findings and prevent inconsistencies that may arise from researcher biases (Lincoln & Guba, 1985; Başkale, 2016). Therefore, the research process was transparently documented to ensure reliability.

Finally, in line with the Transferability criterion, the applicability of the findings of the study in similar contexts was aimed. Guba and Lincoln (1982) suggest that in order to ensure transferability, the sample should be purposively selected and the concepts and themes should be conveyed with detailed descriptions and direct quotations while remaining faithful to the nature of the data. In this study, a purposive sampling strategy was used to ensure transferability. Participants were selected from individuals with in-depth knowledge and experience in blockchain technology and SCM. Diversity was ensured by taking into account the sectoral distribution of the participants (public consultancy, logistics, banking, software development, etc.) and their length of professional experience (10 to 34 years). The codes and themes obtained were conveyed through dense descriptions and direct quotations of the participants were included. This strengthened the usability of the data in other contexts (Yıldırım & Şimşek, 2013; Creswell, 2019).

As a result, in this study, the criteria of credibility, dependability, confirmability and transferability were rigorously applied to ensure trustworthiness. The research process was conducted transparently and the reliability of the findings was ensured through participant confirmations, expert evaluations and direct quotations. In this way, the study has been structured in accordance with qualitative research methods and meets scientific credibility criteria.

Table 19*Trustworthiness Criteria and Strategies*

Criteria	Strategies
Credibility	Prolonged interaction Participant checking Expert opinion and peer review (peer debriefing) Intensive descriptions and direct quotations
Dependability	Systematic recording of the data collection process Iterative control of the coding process Expert opinion and external audit
Confirmability	Recording the interviews Multiple checks during the coding process Analysis supported by direct quotes Archiving of all data
Transferability	Purposive sampling strategy Participant profile and sector diversity Transferring codes and themes with direct quotations

Source: Created by Author

CHAPTER 4. RESULTS AND DISCUSSION

This chapter presents the findings under two main headings. First, quantitative and qualitative findings are presented. Then, there is a discussion section in which the findings based on both methods are compared and synthesized. In the discussion section, the results obtained are evaluated within our framework of the existing literature and a holistic interpretation is also presented.

4.1. Results of Quantitative Method: Ranking Analysis via Expert Survey

In this section, the results of the ranking analysis for the adoption of blockchain technology in SCM are reported in line with expert opinions. According to the calculated RII values, the overall ranking and in-group ranking of each variable are presented in the table, and these rankings reflect the relative importance of the variables in the context of Türkiye.

The importance level of each variable is determined as High, High-Medium, Medium, Medium, Medium-Low and Low, taking into account the classification proposed by Chen et al. (2010). In line with Chen et al.'s approach, the range of $0.8 < GME \leq 1.0$ is classified as High, $0.6 < GME \leq 0.8$ as High-Medium, $0.4 < GME \leq 0.6$ as Medium, $0.2 < GME \leq 0.4$ as Medium-Low and $GME \leq 0.2$ as Low.

4.1.1. General Evaluation: Consolidated Expert Opinions

This part presents the results of the ranking analysis based on consolidated expert opinions on the adoption of blockchain technology in SCM. The analysis evaluates the importance of factors in the Turkish context according to their RII (Relative Importance Index) values. The factors are grouped under the categories T (T, O (Organizational), E (Environmental), INNO (Innovation-specific) and IND (Individual), and the overall rank (Cumulative Rank) and the in-group rank of each factor are determined. These rankings reveal the relative priorities of the factors and are presented without discrimination between expert profiles.

The results of the analysis are presented in Table 20, which includes the RII values, cumulative rankings, and in-group rankings of the factors. Additionally, each variable's importance level is classified as High (H), High-Medium (H-M), or Medium (M).

Table 20*Ranking of Critical Blockchain Adoption Factors*

<i>Group No</i>	<i>Factors</i>	<i>RII</i>	<i>Cum. Rank</i>	<i>In-group Ranking</i>	<i>Importance Level</i>
O9	Top Management Support	0.91	1	1	H
O3	Organizational Readiness	0.87	2	2	H
O11	Managerial Level Technology Affinity	0.85	3	3	H
E2	Regulatory Support	0.84	4	1	H
E4	Trade Partner Pressure	0.83	5	2	H
E8	Competitive Pressure	0.83	6	3	H
E1	Regulatory Environment Uncertainty	0.82	7	4	H
E7	Industry Pressure	0.82	8	5	H
IND3	Trust in Technology	0.82	9	1	H
O6	Lack of Technical and Digital Knowledge	0.81	10	4	H
O5	Technological Capabilities	0.81	11	5	H
IND1	Perceived Benefits of Technology	0.81	12	2	H
O2	Resistance to Change	0.80	13	6	H
E6	Customer Interest	0.79	14	6	H-M
IND2	Perceived Ease of Use / Effort Expectation	0.79	15	3	H-M
O8	Cost Concerns	0.79	16	7	H-M
IND5	Affinity for Technology	0.78	18	4	H-M
INNO1	Relative Advantage	0.78	17	1	H-M
E3	Standardization Uncertainty	0.77	19	7	H-M
E10	Information Sharing	0.77	20	8	H-M
IND4	Facilitating Conditions	0.77	21	5	H-M
IND7	Innovativeness	0.77	22	6	H-M
E11	Lack of Successful Examples	0.76	24	9	H-M
O7	Human Resource Adequacy	0.76	23	8	H-M
O4	Financial Resources	0.76	25	9	H-M
INNO4	Maturity	0.75	26	2	H-M
INNO5	Blockchain Transparency	0.75	27	3	H-M
O1	Organizational Culture	0.75	28	10	H-M
INNO3	Compatibility	0.74	30	4	H-M
O13	Trust in Technology	0.74	29	11	H-M
E5	Vendor Support	0.73	32	10	H-M
T2	Technological Immaturity	0.73	31	1	H-M
IND6	Social Impact	0.72	33	7	H-M
INNO2	Complexity	0.72	34	5	H-M
T7	Technology Implementation Cost	0.71	35	2	H-M
E13	Perceived Network Development	0.68	37	12	H-M
E9	Market Dynamics	0.68	36	11	H-M
T3	Existing Information Technology Infrastructure	0.67	38	3	H-M
T1	Technological Volatility	0.65	39	4	H-M
O10	Other Technology Priorities	0.63	40	12	H-M
T8	Privacy Concerns	0.61	41	5	H-M
T9	Security Risk	0.60	42	6	H-M
E14	Cultural Differences Among Supply Chain Partners	0.60	43	13	M
O14	Firm Size	0.58	44	13	M
O12	Perceived Data Quality	0.57	45	14	M
T4	Scalability	0.55	46	7	M
E12	Sustainability Issues	0.54	47	14	M
T10	Usability in Informal Economies	0.53	48	8	M
T6	High Energy Consumption of Technology	0.53	49	9	M
T5	Technology Characteristics: Trial and Feedback	0.52	50	10	M

Notes: The factors in the table are ranked from largest to smallest according to their RII (Relative Importance Index) values. The colors used in the table represent the factor categories. Accordingly, pink row represents organizational factors; green rows represent environmental factors; yellow rows represent technological factors; blue rows represent innovation-specific variables; and beige rows represent individual factors.

As indicated by the analysis results in Table 20, organizational factors stand out as the most critical elements in the adoption of blockchain technology, and the top three ranked factors belong to this category. *Top Management Support* ranks first with the highest RII value (0.91) and emphasizes the importance of the active involvement of top management, including the adequate allocation of human, financial, and infrastructural resources. This is followed by *Organizational Readiness* (RII = 0.87), which reveals that an organization's financial, technological, human resource, and knowledge capacity are essential for adopting and effectively using blockchain technology. The third factor, *Management Level Technology Affinity* (RII = 0.85), shows the importance of the management team's interest and commitment to blockchain technology as a facilitator of organizational innovation and adoption. Taken together, these factors suggest that organizational readiness and leadership play a fundamental role in blockchain integration.

After organizational factors, environmental factors rank high in the adoption of blockchain technology according to expert opinions (from 4th to 8th place). The results of the analysis reveal that environmental factors play a decisive role in the adoption of this technology. For instance, *Regulatory Support* (RII = 0.84), *Trading Partner Pressure*, and *Competitive Pressure* (both RII = 0.83) emphasize the necessity of an appropriate regulatory framework and a competitive environment for the viability and sustainability of this technology. Especially for the public sector, regulatory uncertainty and support can have a significant impact on the technology adoption process. In addition, *Uncertainty of the Regulatory Environment* (RII = 0.82) and *Industry Pressure* (RII = 0.82) also have significant importance in this process. *Regulatory Support* refers to policy and legal regulations that encourage the adoption of blockchain technology, while *Trading Partner Pressure* refers to the role of trading partners in encouraging adoption. Similarly, *Competitive Pressure* indicates the motivation and internal pressures to gain a competitive advantage in the adoption of innovative technologies. These findings suggest that environmental factors should be considered as a strategic priority in the adoption of blockchain technology.

According to the results of Table 20, after organizational and environmental factors, the variable *Trust in Technology* (RII = 0.82) in the individual factors category ranks first in its category and ninth in the overall ranking. This indicates that the belief in the trustworthiness of technology plays a critical role in the adoption of blockchain

technology. *Trust in Technology* refers to the belief that blockchain technology can effectively perform tasks and streamline processes, and this trust positively affects adoption. Two other variables that stand out among individual factors are *Perceived Benefits of Technology* (RII = 0.81) and *Perceived Ease of Use / Effort Expectation* (RII = 0.79). While *Perceived Benefits of Technology* emphasizes the belief that blockchain technology will increase business performance and efficiency, *Perceived Ease of Use / Effort Expectation* is associated with the ease of use, understandability, and simplicity of the system. These findings clearly reveal that individuals' perceptions of technology have a decisive impact on the adoption process.

Based on the analysis, in the technological factors category, *Technological Immaturity* (RII = 0.73) ranks first in its category but ranks 31st in the overall ranking. Similarly, *Technology Implementation Cost* (RII = 0.71) ranked 35th, and *Existing Information Technology Infrastructure* (RII = 0.67) ranked 38th. These rankings indicate that these factors are evaluated with a relatively lower importance compared to other categories. However, according to the results of the analysis, these factors are determined to be of high-moderate importance. *Technological Immaturity* refers to the relative newness of blockchain technology and limited commercial applications, while *Technology Implementation Cost* is associated with high implementation costs and uncertainty of return on investment. *Existing Information Technology Infrastructure* highlights the difficulties in replacing or adapting existing legacy systems with blockchain. These results suggest that technological factors are not completely unimportant in blockchain adoption but are less influential than the other categories.

A remarkable result in the ranking analysis is that the variable *Relative Advantage* (RII = 0.78), which is included in the innovation-specific factors group, ranks 17th in the overall ranking at the high-moderate importance level, although it ranks first in its category. The other factors in the same category, *Maturity* (RII = 0.75) and *Blockchain Transparency* (RII = 0.75), ranked 26th and 27th in the overall ranking respectively, while *Compatibility* (RII = 0.74) and *Complexity* (RII = 0.72) ranked 30th and 34th respectively. These results show that the relative advantages of blockchain technology to existing technologies, its compatibility with existing business processes and technologies, its immature structure, transparency, and perceived complexity are of lower importance compared to organizational and environmental factors.

Relative Advantage refers to the perception that blockchain technology offers superior benefits compared to existing technologies, while *Maturity* reveals the limitations and immaturity of blockchain technology in commercial applications. *Blockchain Transparency* highlights the transparency, traceability, and verifiability features of blockchain transactions as a facilitator of adoption. *Compatibility* refers to the compatibility of the technology with existing values, past experiences, and organizational culture, while *Complexity* draws attention to the difficulty of understanding and using blockchain technology. These factors are ranked relatively lower, which may reflect the fact that blockchain technology is still in its developmental stage, and therefore, different priorities are being taken into account in the adoption process. The low RII value (0.72) of the *Complexity* factor indicates that experts do not see the complexity of blockchain technology as an insurmountable obstacle. This may be indicative of a growing confidence in the technology and its adaptability.

On the other hand, the last eight variables with the lowest RII value and reported at the medium importance level are *Cultural Differences Among Supply Chain Partners*, *Firm Size* (RII = 0.58), *Perceived Data Quality* (RII = 0.57), *Scalability* (RII = 0.55), *Sustainability Issues* (RII = 0.54), *Usability in Informal Economies* (RII = 0.53), *High Energy Consumption of Technology* (RII = 0.53), and *Technology Characteristics: Trial and Feedback* (RII = 0.52). These results indicate that experts consider these factors less important compared to other factors. For example, *Cultural Differences Among Supply Chain Partners* indicates that cultural differences among supply chain actors may make the adoption of blockchain technology difficult, while *Firm Size* indicates that larger firms are more likely to adopt new technologies because they have better risk management capacity compared to smaller firms. *Perceived Data Quality* draws attention to concerns about the accuracy of data in blockchain, while *Scalability* refers to perceptions about the capacity of blockchain technology to handle increasing data volumes.

In addition, *Sustainability Issues* sees environmental concerns arising from the technology's high electricity consumption as a barrier. *Usability in Informal Economies* refers to the potential for blockchain technology to be used in illegal activities such as money laundering, gambling, and terrorism due to its unregulated nature. *High Energy Consumption of Technology* refers to the high energy costs required by the technology,

while *Technology Characteristics: Trial and Feedback* emphasizes the difficulties in the trial and feedback processes of blockchain technology.

The low importance level of these factors indicates that they are not seen as decisive barriers in the adoption process of blockchain technology. In particular, the low importance level of factors such as energy consumption suggests that there may be increased confidence in the solutions developed for energy efficiency and sustainability. This may reflect the fact that experts are focusing on the potential advantages and areas of development of blockchain technology rather than the current challenges in its adoption. Hence, the lower RII values of such factors suggest a shift in priorities in the technology adoption process and a more positive perception of emerging technologies. In this context, the development of strategies to address the organizational and environmental factors that have a higher level of importance can lead to significant and positive progress in the blockchain adoption process.

4.1.2. Ranking Analysis Results Based on Different Expert Profiles

The analysis reveals significant differences in the relative importance and priorities assigned to various factors by different expert profiles. These differences are examined in detail to highlight how perspectives vary across groups. A comprehensive overview of the results, categorized by expert profile, is presented in Tables 21 to 25. In these tables, factors with an RII value above 0.80 and ranking within the top 10 are highlighted in bold for clarity and emphasis.

First, Table 21 illustrates the relative importance index (RII) levels of technological factors according to each expert profile and their corresponding ranking among all factors (i.e. in the aggregate). In the previous analysis, when expert opinions were not disaggregated by profile, technological factors were generally found to be relatively less important than other factors. However, the results of the RII analysis disaggregated by expert profiles reveal that for Policymakers & Practitioners, Security Risk (RII = 0.98) and Privacy Concerns (RII = 0.95) are rated as the two most important factors among all factors. This is quite striking because these factors are ranked 45th and 41st among private sector professionals and 47th and 50th among academics, respectively. The fact that these factors are ranked in the top two in the public sector clearly shows the differences in perspectives between the groups of experts.

Moreover, the fact that public sector professionals are more sensitive to regulatory uncertainties points to the need for a clear and harmonized regulatory framework for the adoption of blockchain technology in this sector. This suggests that regulatory support plays a critical role in the viability and sustainability of blockchain technology in the public sector.

Table 21

Comparative Ranking of Technological Factors by Expert Profile

<i>Group No</i>	<i>Factors</i>	<i>Private Sector Professionals & Practitioners</i>		<i>Policymakers & Practitioners</i>		<i>Academics</i>	
		<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>
T9	Security Risk	0.56	45	0.98	1	0.53	47
T8	Privacy Concerns	0.61	41	0.95	2	0.45	50
T7	Technology Implementation Cost	0.64	38	0.9	6	0.78	25
T1	Technological Volatility	0.64	40	0.78	29	0.6	39
T6	High Energy Consumption of Technology	0.42	50	0.78	30	0.65	37
T2	Technological Immaturity	0.77	15	0.75	35	0.63	38
T5	Technology Features: Trial and Feedback	0.47	49	0.7	39	0.54	44
T3	Existing Information Technology Infrastructure	0.66	36	0.68	44	0.7	35
T4	Scalability	0.55	46	0.65	48	0.49	48
T10	Usability in Informal Economies	0.53	47	0.48	50	0.56	43

Note: Factors are ranked by RII values of the Policymakers & Practitioners, from highest to lowest.

Table 22, below demonstrates the importance and overall ranking of organizational factors according to different expert profiles. The results show that while top management support is highly important for all expert groups, there are differences of opinion on the factor of proximity to technology at the managerial level. Private sector professionals ranked this factor second highest in the overall ranking, while other factors prioritized by the public and academic communities were ranked higher.

For academics, *Organizational Readiness* was seen as the most important factor among all factors, while for policy makers it ranked fourth. *Resistance to Change*, which is

frequently discussed in the literature, was ranked fourth by academics, while *Cost Concerns* was ranked fifth. These results suggest that there are differences between expert groups in terms of the importance of these two factors. However, for the variables *Other Technology Priorities*, *Perceived Data Quality*, and *Firm Size*, which were previously ranked among the least important factors in Table 20, no significant differences were observed according to the expert profiles.

Table 22

Comparative Ranking of Organizational Factors by Expert Profile

Group No	Factors	Private Sector Professionals & Practitioners		Policymakers & Practitioners		Academics	
		RII	Cum. Rank	RII	Cum. Rank	RII	Cum. Rank
O9	Top Management Support	0.92	1	0.95	3	0.85	6
O11	Managerial Level Technology Affinity	0.87	2	0.83	19	0.83	15
O5	Technological Capabilities	0.84	5	0.68	45	0.81	18
O3	Organizational Readiness	0.83	7	0.93	4	0.93	1
O6	Lack of Technical and Digital Knowledge	0.8	10	0.85	13	0.83	14
O2	Resistance to Change	0.77	16	0.85	12	0.85	4
O4	Financial Resources	0.76	19	0.7	40	0.79	23
O8	Cost Concerns	0.76	20	0.83	18	0.85	5
O1	Organizational Culture	0.75	22	0.78	31	0.73	34
O7	Human Resource Adequacy	0.73	25	0.85	14	0.78	26
O13	Trust in Technology	0.68	33	0.83	20	0.81	19
O10	Other Technology Priorities	0.66	37	0.7	41	0.54	45
O12	Perceived Data Quality	0.59	42	0.68	46	0.48	49
O14	Firm Size	0.58	43	0.68	47	0.54	46

Note: Factors are ranked by RII values of the Private Sector Professionals & Practitioners, from highest to lowest.

Third, the relative importance levels and rankings of environmental factors according to different expert profiles are presented in Table 23. The results show that environmental

factors are characterized as more important, especially by private sector professionals and practitioners. While similar views are observed between the expert profiles on *Regulatory Support*, there are significant differences of opinion on *Regulatory Environment Uncertainty*.

In addition, the close ranking results between private sector professionals and policymakers for the *Competitive Pressure* and *Industry Pressure* factors suggest that these groups have similar assessments. However, for the *Trade Partner Pressure* factor, the views of private sector professionals and academics are more aligned. Moreover, unlike the other expert profiles, the *Lack of Successful Example* factor ranks 10th among all factors and is reported at a high level of importance according to the assessment of policymakers. For academics, *Customer Interest* and *Information Sharing* are ranked 9th and 10th out of 50 factors, respectively. These results reveal that contextual priorities and evaluations vary in the adoption of blockchain technology according to expert profiles.

Table 23

Comparative Ranking of Environmental Factors by Expert Profile

<i>Group No</i>	<i>Factors</i>	<i>Private Sector Professionals & Practitioners</i>		<i>Policymakers & Practitioners</i>		<i>Academics</i>	
		<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>
E1	Reg. Environ. Uncertainty	0.85	3	0.83	21	0.75	29
E8	Competitive Pressure	0.85	4	0.88	9	0.76	27
E7	Industry Pressure	0.84	6	0.88	8	0.75	31
E2	Regulatory Support	0.83	8	0.9	7	0.85	7
E4	Trade Partner Pressure	0.82	9	0.85	15	0.85	8
E3	Standardization Uncertainty	0.78	14	0.8	24	0.75	30
E11	Lack of Successful Examples	0.77	17	0.88	10	0.68	36
E6	Customer Interest	0.76	18	0.83	22	0.85	9
E10	Information Sharing	0.74	24	0.75	36	0.85	10
E5	Vendor Support	0.71	27	0.8	25	0.74	33
E9	Market Dynamics	0.71	30	0.8	26	0.58	42
E13	Perceived Network Development	0.64	39	0.73	38	0.75	32

Table Continued

E14	Cul. Diff. Among Supply Chain Partners	0.57	44	0.7	42	0.6	41
E12	Sustainability Issues	0.5	48	0.63	49	0.6	40

Note: Factors are ranked by RII values of the Private Sector Professionals & Practitioners, from highest to lowest.

Table 24 below shows the relative importance levels and overall rankings of innovation-specific variables according to different expert profiles. The innovation-specific factors, which were previously reported as relatively less important and ranked lower in Table 20, reveal significant differences when analyzed in terms of expert profiles.

As seen in the table, Compatibility and Blockchain Transparency were rated as the second and third variables with the highest RII values by academics. However, these factors were rated at lower levels of importance by other expert profiles. Similarly, Relative Advantage ranked 11th for academics, 23rd for private sector professionals and 37th for policy makers, clearly reflecting the difference in opinion between the expert groups.

Table 24

Comparative Ranking of Innovation to Specific Factors by Expert Profile

<i>Group No</i>	<i>Factors</i>	<i>Private Sector Professionals & Practitioners</i>		<i>Policymakers & Practitioners</i>		<i>Academics</i>	
		<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>
INNO3	Compatibility	0.67	34	0.8	28	0.86	2
INNO5	Blockchain Transparency	0.71	28	0.7	43	0.86	3
INNO1	Relative Advantage	0.75	23	0.75	37	0.85	11
INNO2	Complexity	0.66	35	0.8	27	0.81	20
INNO4	Maturity	0.71	31	0.85	16	0.8	21

Note: Factors are ranked by RII values of the Academics, from highest to lowest.

Lastly, Table 25 reflects the ranking results and relative importance levels of individual factors according to expert profiles. According to the table, a noteworthy result is that *Affinity for Technology*, which is ranked fifth for policy makers, is ranked 12th for academics and 29th for private sector professionals.

In addition, there is a consensus among the expert profiles regarding the importance of the *Trust in Technology* variable. The variables *Perceived Benefits of Technology* and *Perceived Ease of Use* were evaluated as more important for private sector professionals and academicians, and the relative importance of these factors in different profiles became evident.

Table 25

Comparative Ranking of Individual Factors by Expert Profile

<i>Group No</i>	<i>Factors</i>	<i>Private Sector Professionals & Practitioners</i>		<i>Policymakers & Practitioners</i>		<i>Academics</i>	
		<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>	<i>RII</i>	<i>Cum. Rank</i>
IND5	Affinity for Technology	0.71	29	0.93	5	0.85	12
IND3	Trust in Technology	0.8	11	0.88	11	0.84	13
IND4	Facilitating Conditions	0.73	26	0.85	17	0.8	22
IND1	Perceived Benefits of Technology	0.79	12	0.83	23	0.83	16
IND2	Perceived Ease of Use	0.78	13	0.78	32	0.83	17
IND6	Social Impact	0.69	32	0.78	33	0.76	28
IND7	Innovativeness	0.76	21	0.78	34	0.79	24

Note: Factors are ranked by RII values of the Policymakers & Practitioners, from highest to lowest.

In conclusion, the priorities of different expert profiles towards blockchain adoption clearly demonstrate the importance of sectoral and interdisciplinary approaches. While public sector experts focus on security and privacy issues, private sector experts emphasize that top management support and technological proximity at the managerial level, as well as regulatory support, regulatory environment and external pressures are decisive in the technology adoption process. For academics, *Organizational Readiness* stands out as the most important variable, while innovation-specific factors such as *Compatibility* and *Blockchain Transparency* were also found to be noteworthy.

Therefore, when developing strategies for blockchain technology, organizational structures, environmental conditions and security measures, as well as sectoral and

interdisciplinary differences should be carefully considered. This approach will play an important role in ensuring more effective adoption and integration of the technology.

4.2. Results of Qualitative Method: Focused Analysis of Interviews

This section presents the results of the analysis of the interviews on the adoption of blockchain technology in SCM. This qualitative research, conducted through Focused Analysis of Interviews, provides a comprehensive analysis of the barriers faced in the technology adoption process and suggestions and strategies to overcome these barriers. The interview findings aim to provide an in-depth understanding of the contextual and perceptual dynamics of blockchain technology adoption. In this context, the findings are reported under two main headings:

In this context, the findings are reported under two main headings: Interview Findings I : Barriers to Blockchain Adoption in SCM and Interview Findings II: Strategies and Recommendations for Blockchain Adoption.

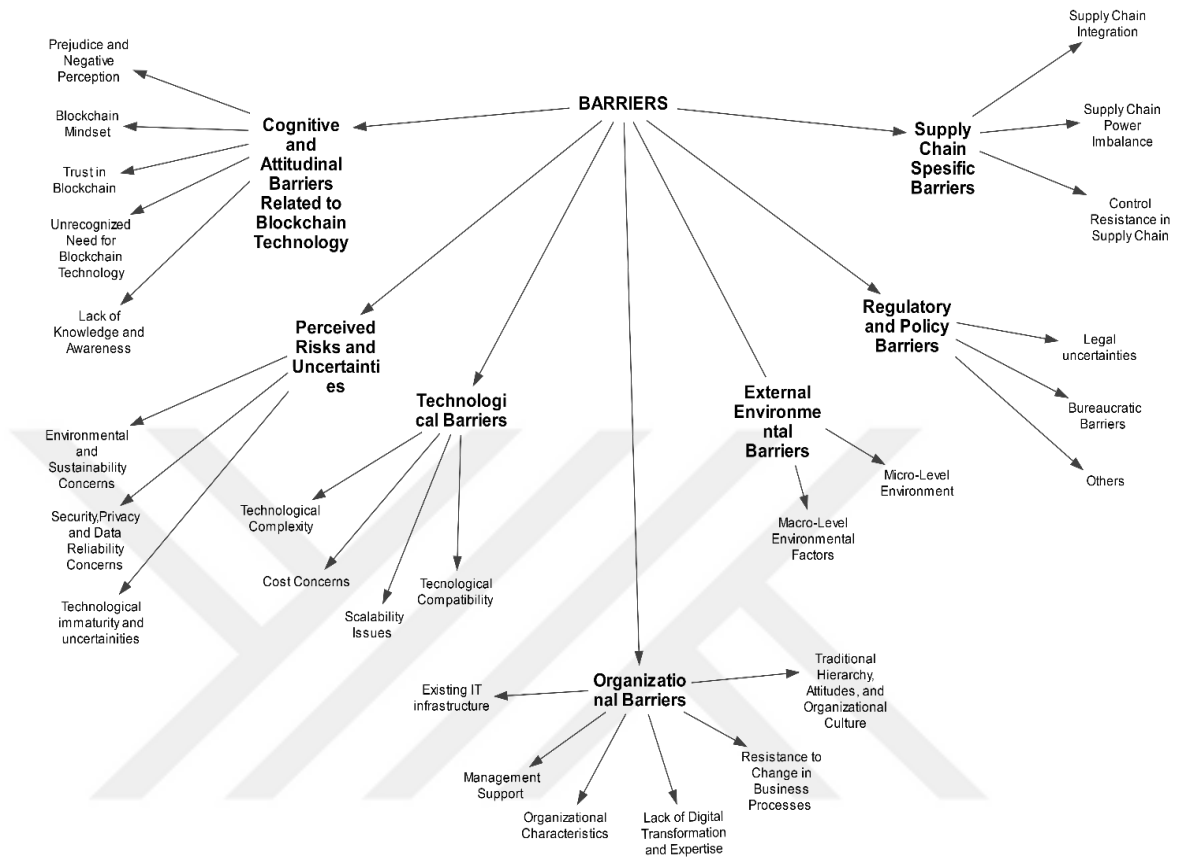
4.2.1. Interview Findings I: Barriers to Blockchain Adoption in SCM

Based on the participants' views, the analysis revealed that the barriers to the adoption of blockchain technology can be classified into seven main categories. These categories are as follows: "Cognitive and Attitudinal Barriers Related to Blockchain Technology," "Perceived Risks and Uncertainties," "Technological Barriers," "Organizational Barriers," "Regulatory and Policy Barriers," "External Environmental Barriers," and "Supply Chain-Specific Barriers."

Each main category was evaluated according to the content of the codes identified during the analysis process. In line with this assessment, first-level, second-level, and/or third-level subcategories have been defined. These categories and subcategories aim to explain the multidimensional nature of the barriers to blockchain adoption. Under this section, each category and its subcategories will be discussed in detail, supported by participants' statements. Figure 22 below illustrates the seven main categories and their subcategories.

Figure 22

Main Categories and Subcategories of Barriers for Blockchain Adoption



The barriers to blockchain adoption are detailed in the diagram above under seven main categories and their subcategories. In this context, starting with cognitive and behavioral barriers, each category will be addressed sequentially.

4.2.1.1. Cognitive and Attitudinal Barriers

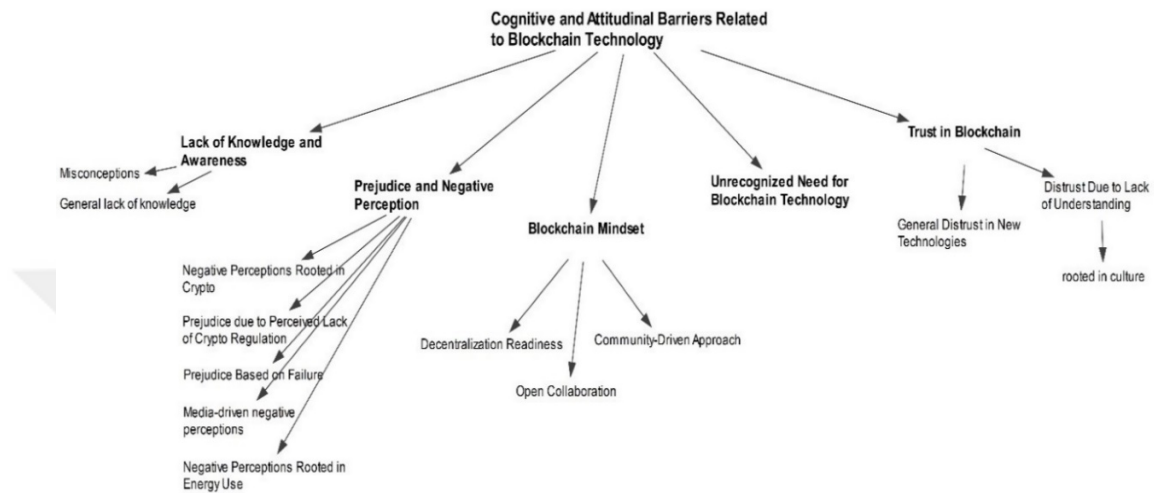
The first category of barriers to blockchain adoption is defined as "Cognitive and Attitudinal Barriers Related to Blockchain Technology". This category includes factors that shape individuals' perceptions and belief structures about blockchain technology. Cognitive barriers reflect the thought patterns and attitudes of the participants that affect their approach towards the technology. The analysis of participant statements revealed that cognitive and attitudinal barriers to blockchain adoption are based on a number of factors.

Accordingly, the cognitive and attitudinal barriers associated with blockchain are categorized under five main headings: failure to identify the need for blockchain

technology, prejudices, and negative perceptions, lack of knowledge and awareness, blockchain mindset, and blockchain trust. In the Figure 23 below, these cognitive and attitudinal barriers are visualized with subcategories and codes.

Figure 23

Code & Sub-Code Hierarchy Map of Cognitive and Attitudinal Barriers

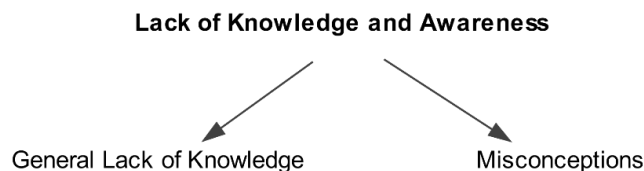


4.2.1.1.1. Lack of Knowledge and Awareness.

The first sub-category under the main category of "*Cognitive and Attitudinal Barriers*" of the barriers to blockchain adoption was determined as "*Lack of Knowledge and Awareness*". Participants stated that lack of knowledge and misunderstandings are among the main factors preventing the adoption of the technology. These deficiencies, which are discussed under two main sub-categories(as seen Figure 24), namely *General Lack of Knowledge* and *Misunderstandings*, make it difficult to understand and popularize blockchain technology.

Figure 24

Subcodes of Lack of Knowledge and Awareness



General Lack of Knowledge reveals that there is a serious lack of knowledge about blockchain technology in the general public. P8 expressed this situation clearly, stating that the society still has a beginner level of knowledge about blockchain as follows:

"...there are still people a little bit above the zero point." (P8, 12). He also emphasized that the lack of knowledge about data infrastructure causes awareness to remain limited: *"people did not know that there was a data infrastructure...." (P8, 15).*

Similarly, P9 highlighted the difficulty in understanding blockchain and the uncertainties surrounding its benefits and costs:

"...everyone is following and trying to grasp it from the edge, trying to understand. It is also very hard to understand. They are asking, 'What will it bring to us? What will the cost be? Can we afford it?'" (P9, 34-37).

P1, on the other hand, stated that not knowing the capabilities of the technology sufficiently prevented the formation of trust and said the following:

"No one is aware of the capabilities of blockchain." (P1, 78-86).

These statements show that lack of knowledge has a negative impact not only on awareness but also on trust.

Misconceptions show that common misconceptions about blockchain technology hinder a proper understanding of the technology. In particular, participants stated that the frequent association of blockchain with cryptocurrencies leads to overlooking other potential use cases of the technology. P8 explained this situation as follows:

"people could not distinguish between crypto money and blockchain technology due to this lack of knowledge." (P8, 14).

Similarly, P1 emphasized that Bitcoin is just an application form of blockchain technology, but this distinction is not well known:

"...everyone is already fed up with Bitcoin, or because they cannot focus on anything else, they cannot perceive that there is an application for this under the blockchain, and that there is nothing else other than a fintech application..." (P1, 75-77).

It was frequently mentioned by participants that misconceptions create negative perceptions of blockchain technology and overshadow its potential for wide use. P12 stated that risky structures such as Bitcoin lead to misunderstanding of blockchain technology as follows:

"The fact that blockchain technology is mostly known for crypto assets..., ... the incidents that occur in these areas where people lose their assets and fortunes are also one of the obstacles to blockchain technology ." (P12, 42-44).

As a result, lack of knowledge and awareness emerges as a serious obstacle to the adoption of blockchain technology. In this context, participants emphasized that accurate information and awareness-raising activities are critical for the understanding and diffusion of the technology.

4.2.1.1.2. Unrecognized Need for Blockchain Technology.

The second sub-category under the main category of "Cognitive and Attitudinal Barriers" to blockchain adoption was determined as "Unrecognized Need for Blockchain Technology". The analysis based on the interview data showed that the participants were uncertain about the need for blockchain technology and this negatively affected the adoption process.

Participants stated that the necessity of blockchain technology is not sufficiently questioned and that trying to implement this technology due to popularity or competitive pressure hinders an effective adoption process. For example, P2 stated that the use cases suitable for the nature of blockchain technology were not sufficiently evaluated as follows:

"... there is p2p in the nature of blockchain, so if you are not building a system between 2 parties, yes, don't do blockchain anyway.... just saying that I will implement it within the organization is actually against the nature of blockchain (P2).

Some participants emphasized that the technology is being used in the wrong places due to its popularity. P3, referring to the tendency of blockchain to become popular, stated as follows:

"Whatever you do with blockchain, it somehow becomes popular. You make headlines somewhere." (P3).

P7 stated that blockchain technology was put on the agenda due to the concern of catching up with the trends:

"it is not our main agenda, but of course we have concerns about catching up with trends and adapting them to our business, as everyone does (P7).

Other participants questioned the applicability of the technology and its potential benefits. P4 expressed doubts about the functionality of the technology, stating the following:

"... Why is he going to do that? Is it because it will be more profitable or because it will reduce costs, or how will it be, will it be able to give up control?"

... I mean, is it ready for a truly decentralized structure or not? If not, it cannot be implemented, and it already fails in implementation tests. Then there are bigger problems in real life. (P4).

Some participants pointed out that the need for blockchain technology needs to be analyzed properly. P6 expressed this situation as follows:

"The need for blockchain should be well identified. Let's move on to blockchain, it is a magic word, the places where it is really needed should be well identified. (P6).

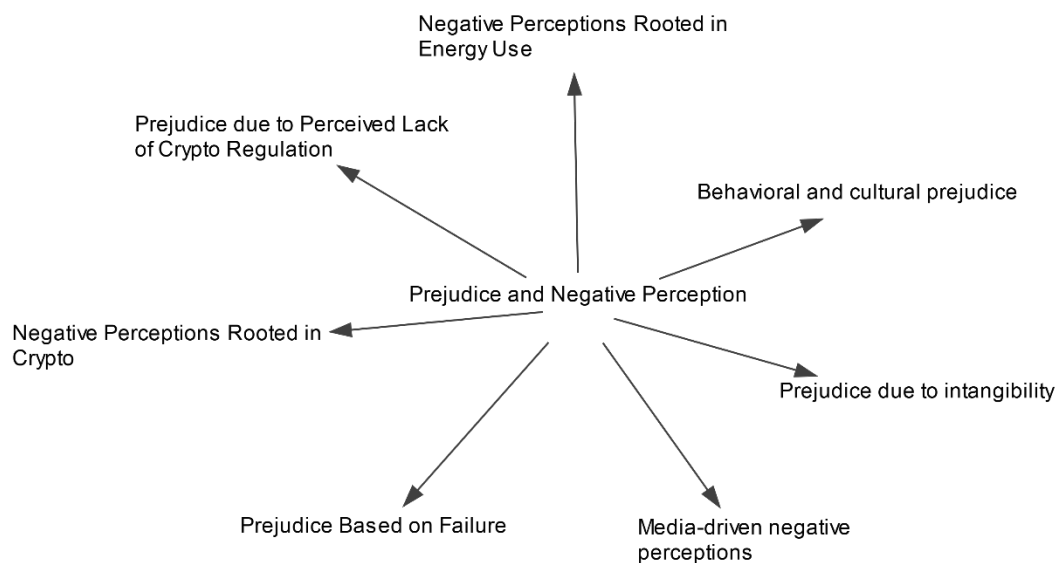
The findings show that mistakes made in determining the need for blockchain technology lead to underutilization of its potential.

4.2.1.1.3. Prejudice and Negative Perception.

The third sub-category under the main category of "Cognitive and Attitudinal Barriers" of the barriers to blockchain adoption was determined as "Prejudice and Negative Perception". Participant statements reveal different dimensions of these prejudices.

Figure 25

Subcodes of Lack of Knowledge and Awareness



Some participants stated that blockchain technology is not understood correctly due to *Negative Perceptions Rooted in Crypto*. P12 stated that this perception leads to trust issues as follows:

"... when you say cryptocurrency, damn it. Let it go down anyway. We went bankrupt too, so it creates a perception that these people are scammers and so on..." (P12, 44-45).

Some failed blockchain projects in the past have been found to be effective in creating *Prejudice Based on Failure*. P2 explained this situation as follows:

"...there were a lot of shaken projects created in the past, ... people who said that such a blockchain project would be very good, etc., but it did not do anything and left and took their money and left..." (P2, 136).

P3 stated that bad examples prevent new projects from starting:

"...if it does not meet a certain need, it is more unsuccessful. Since these are bad examples, people do not want to attempt the project again because they are bad examples due to failure." (P3, 40).

Participants stated that the trust in blockchain technology has decreased due to *Media-driven negative perceptions*. P8 stated that this perception led to a loss of trust as follows:

"In Türkiye, stories about failed stock markets, lost money, and investments made without proper knowledge have been widely covered in the media. This has created a huge trust issue, as the media has often sensationalized and magnified negative examples." (P8, 10).

The same participant emphasized that media influence triggers speculation with the following words: *"I saw a news report that gold and bitcoin made the most money in 2023. This kind of news can lead people to make speculative investments. If Bitcoin fails, blockchain technology will also suffer." (P8, 55).*

Prejudice due to Perceived Lack of Crypto Regulation were also cited as another factor that reduces trust in blockchain technology. P8 expressed this situation as follows:

"...because people cannot distinguish between blockchain and cryptocurrency, because in their minds, this regulation, that is, the regulation of something creates a perception as if it harms the society and the public is protected..." (P8, 14)

Some participants stated that they are distant from blockchain technology due to *Negative Perceptions Rooted in Energy Use*. P2 made the following statement in this regard:

"Yes, there is energy consumption, but when you look back, it's not even a fifth of the alternative systems ... it absorbs all the world's energy, and it does! That's a lie ..." (P2, 77-81).

Behavioral and Cultural prejudice are also one of the important factors affecting technology adoption. P8 expressed this situation as follows:

"Turkish people have a habit of seeing, touching, and experiencing something firsthand before trusting it.." (P8, 10).

It was also stated that blockchain technology is complex and difficult to understand due to *Prejudice due to Intangibility*. P5 expressed this situation as follows:

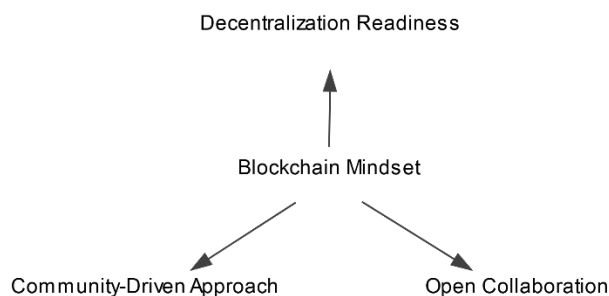
"Transparency is not about revealing the balance sheets, this technology seems strange to people when they listen to it differently. It is necessary to overcome the prejudice of how we will defeat what we cannot understand and cannot hold in our hands, in which issues we are transparent and in which issues we are hidden, what we will see, how much money we need, how efficiently we will work" (P5, 32).

4.2.1.1.4. Blockchain Mindset.

The fourth sub-category under the main category of *"Cognitive and Attitudinal Barriers"* of the barriers to blockchain adoption is defined as *"Blockchain Mindset"*. This concept refers to a thinking system that adopts decentralized structures and includes open collaboration and community-based approaches. However, participants stated that there were various obstacles in the process of adopting this new mindset. The findings addressed these obstacles under the headings of *"Decentralization Readiness"*, *"Open Collaboration"* and *"Community-Driven Approach"*.

Figure 26

Subcodes of Blockchain Mindset



Participants noted a lack of adaptability of communities and organizations to decentralized systems, especially in the context of *Decentralization Readiness*. P4 expressed this shortcoming in the following words:

"Is it ready to implement such a system? In terms of communities, in terms of decentralization. " (P4, 25).

He also mentioned that being unprepared for the idea of decentralization could lead to failures in the testing phases as follows:

"So is it ready for a truly decentralized structure or not? If it is not, it cannot be implemented, and the implementation is already showing up in the tests. Because then there are bigger problems in real life." (P4, 35).

These statements reveal that communities need more preparation and adaptation in the process of adopting a decentralized structure.

Open Collaboration shows that a culture of cooperation and transparency is critical for the successful implementation of blockchain technology. However, participants stated that the centralized and competition-oriented nature of today's business practices makes it difficult to adopt this culture. P4 explained this situation as follows:

"The world is generally not used to structures that work with blockchain. Because the world is capitalist and everyone wants to control and profit themselves." (P4, 36).

The resistance of commercial institutions to working with open and democratic structures also made this process more difficult. P4 said,

"...how can institutions with commercial relations be open to each other and how can they be democratic? ...If they cannot assimilate this, if they cannot understand this ... they cannot make this work. " (P4, 36-41),

emphasizing that this resistance contradicts the collaboration requirements of blockchain technology.

Finally, under *the Community-Driven Approach*, it was stated that communities should adopt an open, democratic and collaborative structure for the successful implementation of blockchain technology. P4 stated that communities should be ready to act in harmony with blockchain as follows:

"How ready are they to act with a community mentality, how ready are they to act democratically, to act openly? If they are not ready, it will be a centralized control system again." (P4, 30). He also emphasized that blockchain adoption is not only a technological transformation, but also requires the development of a culture of cooperation among communities. P4 expressed this in the following words:

"This is not an institutional change. This is communities learning to act together. So it's a sectoral or community-based change within a sector and what you call a community in the supply chain is a system where all the suppliers are each other's suppliers, ultimately producers, customers and so on. All these things have to work in a community mindset." (P4, 34-35).

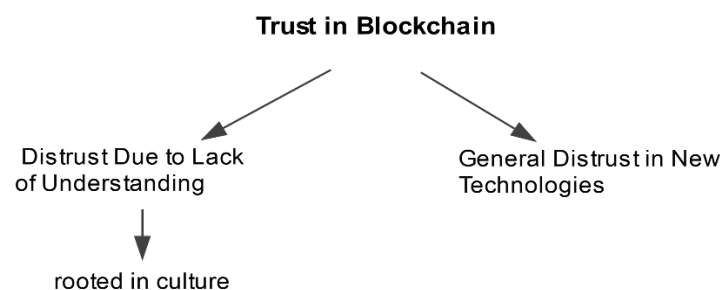
These findings suggest that blockchain technology is not only a technical innovation, but also requires a fundamental shift in mindsets and the adoption of elements such as collaboration between communities, transparency and openness to democratic processes.

4.2.1.1.5. Trust in Blockchain.

According to the results of the qualitative analysis, the fifth subcategory under the main category of *"Cognitive and Attitudinal Barriers"* was defined as *"Trust in Blockchain"*. Although trust is a critical element for the adoption of blockchain technology, it is negatively affected by various factors. Participant statements address the issue of mistrust towards blockchain in two main contexts: *"Distrust Due to Lack of Understanding"* and *"General Distrust in New Technologies"*.

Figure 27

Subcodes of Trust in Blockchain



In the context of *Mistrust Due to Lack of Understanding*, it is stated that the complex structure and technical details of blockchain technology create difficulties in understanding between users and organizations. This makes it difficult to build trust and

negatively affects the adoption process. P8 expressed how lack of knowledge affects trust and adoption processes as follows:

"This ignorance negatively affects both trust and adoption." (P8, 11).

This statement shows that the complexity of the technology can create confusion on the users and this can lead to mistrust.

P11 emphasized the importance of raising awareness to build trust and commented as follows:

"More than legislations, people need to trust the system and trust can only be built through awareness about the system." (P11, 70).

In addition, participants stated that cultural habits are influential in trust-building processes. Especially in Turkish society, trust building is linked to behavioral elements such as touching and experiencing. P8 stated that *".. I believe this mistrust is entirely behavioral and cultural...Turkish people have a habit of seeing, touching, and experiencing something firsthand before trusting it."* (P8, 10). These findings reveal that the lack of trust in blockchain stems not only from a lack of technical knowledge, but also from cultural and behavioral factors.

In the context of *General Distrust of New Technologies*, it was stated that distrust of blockchain technology is not only related to a lack of knowledge, but also to a general distrust of new technologies. Participants stated that new technologies do not provide full trust and this makes the acceptance of blockchain difficult. P2 described the distrust of innovative technologies such as blockchain, especially in the finance sector, as *follows*:

"Finance is like the bedroom of a company. In other words, no one would prefer to continue their lives by transferring it to an online place, because that trust is not fully established yet. ..." (P2, 17).

P8 emphasized the lack of trust and used the following statement:

"Lack of trust is one of the most significant factors." (P8, 10).

These comments suggest that the general distrust of new technologies is a major barrier to the adoption of innovative technologies such as blockchain and that efforts are needed to increase the trustworthiness of the technology.

4.2.1.2. Perceived Risks and Uncertainties

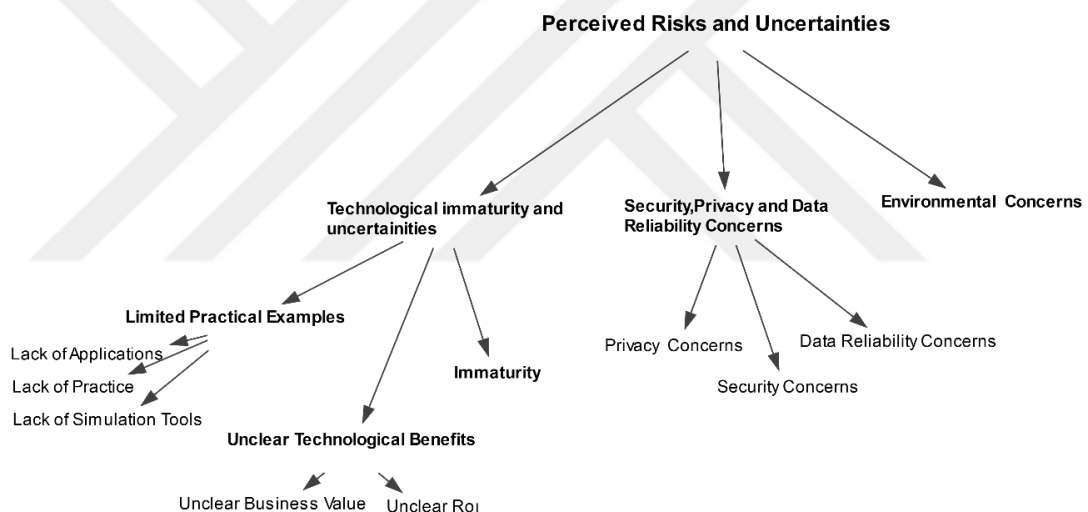
Perceived Risks and Uncertainties was identified as the second main category of barriers to blockchain adoption. Participants stated that the perception of blockchain technology faces various risks and uncertainties.

In line with the qualitative analysis, the risks and uncertainties perceived by the participants regarding blockchain technology were classified under three main subcategories: "Technological Immaturity and Uncertainties", "Security, Privacy, and Data Reliability Concerns", and "Environmental Concerns".

These subcategories and related codes are presented in detail in the visual:

Figure 28

Code & Sub-Code Hierarchy Map of Perceived Risks and Uncertainties



4.2.1.2.1. Immaturity and Uncertainties of Technology.

According to the results of the qualitative analysis, the first sub-category of the main category "Perceived Risks and Uncertainties" was defined as "Immaturity and Uncertainties of the Technology". This sub-category indicates that the blockchain technology is not yet mature enough and the uncertainties created by this situation make it difficult to adopt the technology. In this context, it is analyzed under three main headings: "Immaturity", "Limited Practical Examples" and "Unclear Technological Benefits".

- i. "Immaturity" refers to the fact that blockchain technology has not yet fully matured due to the fact that it is a relatively new technology, which leads to a lack of trust

and slowness in the adoption process. Participants stated that the immaturity of the technology poses an obstacle for businesses. For example, P12 emphasized this situation by saying, "Why should we invest in a technology that has not yet proven itself when there are so many solutions from companies such as Microsoft, SAP, Oracle, etc. in the world? This is a bit like gambling..." (P12, 14). Similarly, P10 stated that the uncertainties about the technology caused businesses to abstain by stating "The fact that the technology is new and its capacity is not understood is an obstacle." (P10, 16). Moreover, examples such as IBM and Maersk's failed TradeLens project show that the technology is not yet ready enough at the sectoral level. P10 explained this situation as follows: "The project was closed because other organizations did not want to participate and the technical infrastructure of small firms was not suitable." (P10, 4-8). Participants also stated that the technology had a short history, which made it difficult to build trust: "We are talking about 13-14 years old technology after all." (P2, 12).

ii. *"Limited Practical Examples"* is defined as a barrier caused by the lack of a sufficient number of concrete examples that can demonstrate the potential benefits of blockchain technology. Under this heading, the subcodes *"Lack of Applications"*, *"Lack of Simulation Tools"* and *"Lack of Practice"* stand out. First, ***the Lack of Applications*** sub-code is one of the most important barriers to the adoption of blockchain technology. Participants stated that due to the inadequacy of existing applications, businesses cannot fully see the advantages offered by blockchain and therefore trust in the technology remains weak. One participant stated that more simulations and applications are needed to demonstrate the tangible benefits of blockchain technology as follows:

"Really concretely, when I enter the statistical data of the benefit I will provide, if I had done this job using blockchain technology, I would have provided such a benefit with the advantages at these points... when I have these simulations, when the model works like this, I think the level of persuasion will be much higher." (P7, 45).

In addition, another participant also mentioned this situation and stated that the practices have not yet become widespread enough: *"Because the applications are not yet widespread"* (P1, 75). These statements emphasize that the lack of implementation reduces the sense of trust due to the lack of examples to adequately demonstrate the potential of the technology.

Secondly, ***the Lack of Simulation Tools*** sub-code makes it difficult to present the benefits of blockchain technology in a convincing way. Participants stated that the lack of

simulation tools that can more clearly demonstrate the advantages of blockchain weakens the belief of both users and businesses in the technology. One participant explained this situation as follows:

"There is a need for simulations to eliminate these difficulties. In other words, if we have simulations ready to show the benefit, we can act faster in terms of persuasion and implementation." (P7, 25).

Another participant stated that simulations can increase trust by providing concrete examples:

"Now there is a dream involved, that is, a technology that we do not know very concretely what we will encounter... If we have simulations to eliminate these difficulties, we can move faster in persuasion and implementation." (P7, 24-25).

This indicates that the lack of simulation tools makes it difficult to understand the potential benefits of the technology and to realize the persuasion process through these benefits.

Finally, ***the Lack of Practical Experience*** sub-code reveals the challenges posed by the lack of widespread testing of blockchain technology, which does not provide sufficient experience in real-world applications. One participant stated that it is difficult to understand the theoretical benefits of blockchain technology without testing it in the field: *"We are talking about an experimental field. These experimental areas may not always produce the desired results, but it is very difficult to predict this in advance. You need to see it in the field." (P12, 19).*

Another participant stated that blockchain does not yet have enough applications in Türkiye and therefore trust in the technology has not developed: *"I can say that these practical aspects are a bit lacking in Türkiye." (P12, 22).* These statements emphasize the necessity of practicing and gaining experience in the field in order to reveal the full potential of blockchain technology.

iii. ***"Uncertain Technological Benefit"*** is defined as a barrier arising from the lack of clarity on the benefits that blockchain technology will provide to businesses. In this context, the subcodes *"Unclear ROI"* and *"Unclear Business Value"* stand out. Findings from qualitative analyses show that businesses have difficulty in clearly understanding

the advantages offered by blockchain technology and are therefore hesitant to invest in the technology.

In the context of Unclear ROI, Participants stated that they are looking for clarity on the return period and costs of investments in blockchain technology. In particular, it has been observed that businesses focus on cost-benefit analysis before investing in the technology and are reluctant to invest in the technology if these analyses are unclear. One participant expressed this situation as follows:

"Our Turkish people usually think about the first cost. There is the point of when will my investment return to me, what benefit will it bring me." (P2, 15).

Another participant similarly emphasized the need for clarity on the costs and benefits of blockchain technology: *"So they say what will it bring us, what will it cost." (P9, 36).* These statements reveal that if the return on investment (ROI) of blockchain technology is uncertain, businesses have difficulty in trusting the technology and the adoption process slows down.

The uncertainty of the value that blockchain technology will create in business processes (*Unclear Business Value*) causes businesses to hesitate to adopt the technology. Participants stated that they had difficulty comparing the potential benefits of blockchain technology with existing systems (e.g. ERP). One participant stated that the advantages offered by blockchain technology are not fully understood in businesses as follows:

"When I have a customer asking about blockchain—what it can do for them and what benefits it offers—we try to explain it in large meetings with around 100 people in the company, covering topics like supply chain and IT. However, one of the most common questions we face is, 'I already have an ERP system that I invested in. Why should blockchain benefit me?'" (P2, 14).

This statement shows that businesses do not understand the potential business benefit of blockchain technology and have reservations about investing in this technology when they compare it with their existing systems.

Another participant emphasized the cooperation and networking requirements of blockchain technology and stated that if this cooperation cannot be achieved, the technology cannot offer the expected commercial value:

"It needs to create added value for all parties. Everyone has to believe in it... In that case, if you cannot establish that network, then you will not reach a sufficient level commercially, or not enough people will be involved." (P3, 17-18).

This view reveals that the inherent collaboration requirements of blockchain increase the uncertainty of the participants and make the adoption process difficult.

As a result, the uncertainty of the benefits that blockchain technology will provide to businesses, combined with the lack of clarity on the return on investment and business value, is one of the main factors hindering the adoption and dissemination of the technology. In order to eliminate these uncertainties, the cost-benefit analysis of the technology and its advantages in business processes should be clearly demonstrated with concrete examples and simulations.

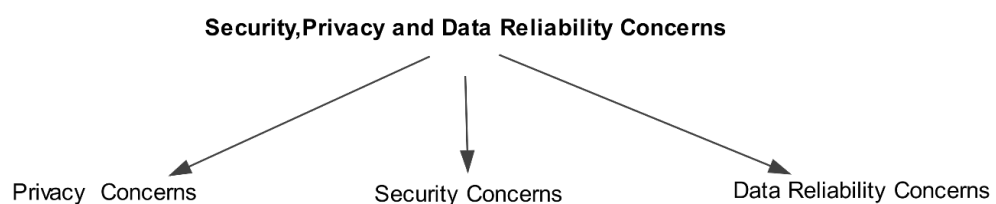
4.2.1.2.2. Security, Privacy and Data Reliability Concerns.

"Security, Privacy and Data Reliability Concerns" was identified as the second sub-category of the main category "Perceived Risks and Uncertainties". This category reveals that the aspects of blockchain technology that need to be improved in terms of security, privacy and data reliability constitute significant barriers to the adoption of the technology.

Participants stated that the vulnerabilities of blockchain technology pose a major risk for businesses that want to implement this technology. They also emphasized that the lack of data reliability and privacy issues make it difficult for the technology to be widely adopted. The concerns expressed by the participants on this issue are analyzed under three main headings: "Security Concerns," "Privacy Concerns" and "Data Reliability Concerns."

Figure 29

Subcodes of Security, Privacy and Data Reliability Concerns



First, *Security Concerns* were cited as a major issue by participants. One participant drew attention to the sense of insecurity created by the sharing of financial data on online platforms such as blockchain. The participant expressed this situation as follows:

"Looking at it today, finance is like a company's bedroom. So, no one would prefer to move this online and continue their business life, because trust has not yet been fully established" (P2, 17).

This statement shows that financial data requires a high level of confidentiality and companies are hesitant to move this data to blockchain platforms. Lack of trust is seen as one of the most important obstacles to the adoption of blockchain technology. However, the participant stated that this situation may change in the future and that an environment of trust may be created as the technology becomes widespread:

"What will happen in the future? As things turn here, as it becomes widespread, once it's understood that you can create privacy over it, these things will increase, but we need to wait and give it time." (P2, 17).

Another participant emphasized that the traditional understanding of doing business creates great hesitation, especially when it comes to sharing their own data externally:

"There is an incredible hesitation in traditional understanding about sharing their own data externally. ... no one wants to share their own information." (P7, 34).

This shows that many businesses are hesitant to share their own data externally and that this concern makes data sharing on distributed systems such as blockchain difficult. The respondents indicated that these reservations are not only technical, but also cultural and habitual.

Another security concern is the certification and permitting processes involved in the use of blockchain technology. One participant mentioned that the complexity of these processes and bureaucratic difficulties make the technology adoption process difficult:

"A number of security concerns and certification issues ... the bureaucracy behind it all becomes exhausting. ... 'Let's stick to what we already know' (P7, 14-15).

Bureaucratic obstacles related to security may lead some companies to give up on blockchain technology.

Perception also plays an important role among security concerns. One participant stated that misunderstandings about the process by which blockchain technology shares transaction information has caused concern in the industry:

"This is where perception comes into play. ... only transaction-related information is shared. ... the perception that everyone will see all the data causes concern in the sector" (P6, 18).

This statement shows that misperceptions about data sharing in blockchain negatively affect companies' decisions to use the technology.

Similarly, concerns about the disclosure of trade secrets were also highlighted. One participant emphasized that such concerns should be overcome through perception management:

"Contracts, sensitive information, and trade secrets are not exposed; perception management is crucial here.." (P5, 27-28).

Although this statement emphasizes that trade secrets and confidential information will not be revealed on the blockchain, it indicates that the perception among participants on this issue still needs to be managed.

Finally, one participant emphasized the portability of blockchain technology and the need to pay attention to security structures in this process:

"What information is shared where, and how much? What is public data, what is private data? ... where and how will this be processed and stored?" (P1, 135-136).

This statement indicates that the security protocols of blockchain systems need to be carefully designed in the process of processing and storing data securely.

Secondly, in the context of **Privacy Concerns**, which data will remain transparent and which data will remain private in blockchain systems stands out as an important source of uncertainty and concern regarding this technology. One participant expressed this situation as follows:

"What aspects are transparent, and what aspects are private? What will we see?" (P5, 32).

This uncertainty is seen as an important obstacle to the secure adoption of blockchain technology. Participants emphasize that more clarity is needed, especially on which information will be shared with whom and which information will be protected.

Another participant stated that not all information is added to the blockchain, but there are misconceptions about this issue:

"Not all information goes to the blockchain; only transaction-related information is shared. ... The perception that everyone will see all the data causes concern in the sector. ... It should be understood that shared information will be visible." (P6, 18).

These misperceptions lead companies and users to develop reservations about privacy. These reservations make it difficult to use blockchain securely and slow down the adoption process of the technology.

Another privacy concern is the fear of trade secrets and confidential information being exposed on the blockchain. One participant stated that these concerns are important, but can be overcome with proper perception management:

"Contracts, sensitive information, and trade secrets are not exposed; perception management is crucial here" (P5, 27-28).

Although this statement emphasizes that confidentiality concerns can be mitigated through perception management, it is understood that there is still a significant reservation about the protection of trade secrets.

Another participant emphasized that the uncertainty of the number of users on the blockchain may affect the transparency and reliability of the system:

"Since it's not a centralized system, this verification is done on the blockchain ... we don't know how many users are connected to the system. ... The system is transparent and reliable, but ... let's call it measurability at that time, is much harder (P11, 19).

This statement shows that the lack of a centralized control mechanism creates some uncertainties in terms of privacy and that users are therefore cautious.

Traditional business practices also pose a significant barrier to privacy. One participant expressed the reservations of companies about opening their data to the outside world as follows:

"Traditional understanding has incredible hesitation about sharing their own data externally. ... No one wants to share their own information..." (P7, 34).

This statement shows that cultural and traditional barriers to privacy make it difficult to adopt blockchain technology.

Finally, in the context of *Data Reliability Concerns*, it was stated that companies are hesitant to adopt this technology because the reliability and accuracy of data in blockchain is not fully understood. One participant expressed this situation as follows:

"The sector is not ready yet; people don't understand the reliability of data in blockchain, and companies are not currently pulling real-time data." (P10, 6).

This statement reveals that companies are hesitant to actively use blockchain technology because they do not have a clear knowledge about data reliability.

Another major concern about data reliability is that when companies move their data to the blockchain system, it will be stored on many servers around the world in a decentralized structure. Since companies are accustomed to keeping their data on their own servers, the decentralized data structure may create a fear of losing control. One participant explained this concern in the following words:

"The company's own data will no longer be on its own server. ... When transitioning to such a system, this data will be encrypted and stored on servers worldwide. Will they accept this?" (P4, 37-38).

This statement shows that the distributed data storage structure offered by the blockchain raises concerns about the security of the data and that companies fear losing control over their data. It may take time for companies to get used to having their data stored encrypted on global servers, making the adoption process difficult.

Such concerns about data trustworthiness stand out as a significant barrier to the widespread adoption of blockchain technology. Companies are demanding more evidence and transparency that the systems in place to secure their data are fully trustworthy. Participants noted that not all information is shared on the blockchain, but transactional information is shared, but even this has raised concerns in the industry:

"Not all information is put on the blockchain, but transactional information. The perception that everyone will see all information causes concern in the sector. It should

not be a problem for the transaction parties to see this, it should be known that the shared information will be seen." (P6, 18).

Moreover, due to the decentralized nature of blockchain technology, uncertainties about how verification is done in the system and how much users are involved in the data verification process also raise concerns. One participant explained this situation as follows:

"Since there is no centralized system, this verification is done on the chain, you know, a verification is done in blockchain technology, and we do not know how many users are connected to the system while doing this verification. So the system is transparent and reliable, but the measurability at that time, let's call it measurability, is much more difficult." (P11, 19).

This statement shows that the transparency and trustworthiness of the system is difficult to measure, and this increases the uncertainties about the reliability of the technology.

Such data reliability concerns pose serious barriers to the adoption of blockchain technology, leading firms to demand greater assurances and transparency before deploying it.

4.2.1.2.3. Environmental Concerns.

"Environmental Concerns" was identified as the third sub-category of the main category "Perceived Risks and Uncertainties"

The fact that blockchain technology is seen as problematic in terms of sustainability increases the concerns of the participants due to the energy-intensive nature of the technology and its impact on the environment. In particular, crypto mining activities call into question the long-term economic sustainability of the technology due to the high energy costs and the imbalance between these costs and the profits generated. Participants emphasize that these imbalances could pose a serious obstacle to the widespread adoption of blockchain technology.

A participant expressed his environmental concerns arising from the high energy consumption required for the verification processes of blockchain technology as follows:

"In terms of environmental factors, the fact that blockchain technology is used for so much validation causes us to have concerns about electricity sources. It creates harm

regarding energy. This also puts us at a disadvantage in terms of carbon emissions" (P11, 19).

While this view reflects a general concern about the environmental impacts of blockchain, it particularly emphasizes the negative impacts on carbon emissions and energy consumption.

Another participant drew attention to global environmental policies related to energy consumption and expressed the impact of sustainability initiatives such as the European Union's green trade and Green Deal on blockchain as follows:

"I don't agree with energy being ranked so low: European standards, green trade, green deal, etc. Energy costs can cause problems" (P5, 37).

This participant stated that energy costs could pose a potential problem for the adoption of blockchain technology.

However, some participants argued that criticisms about the energy consumption of blockchain technology are exaggerated and that there are misunderstandings about this issue. One participant expressed this situation as follows:

"It supposedly consumes all the world's energy, they say! It's nonsense really... Let's take a look at the energy consumed by any bank today. What blockchain consumes is not even one percent of that. We're talking about such small numbers, so don't exaggerate..." (P2, 80-81).

This view argues that the energy consumption of blockchain technology is overestimated when compared to other sectors and finds the criticisms of energy efficiency disproportionate.

As a result, sustainability concerns blockchain technology center around energy consumption and environmental impacts, with divergent views emerging among participants on the long-term economic and environmental sustainability of the technology.

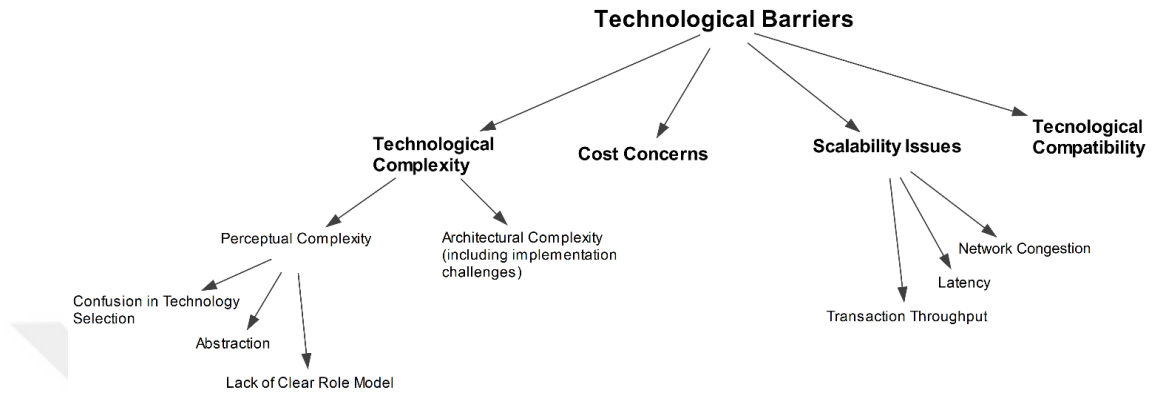
4.2.1.3. Technological Barriers

Technological Barriers were identified as the third main category of barriers to Blockchain adoption. Based on participant statements, four sub-categories of these

barriers were discussed. These are Technological Complexity, Cost Concerns, Scalability Issues and Technological Compatibility.

Figure 30

Code & Sub-Code Hierarchy Map of Technological Barriers



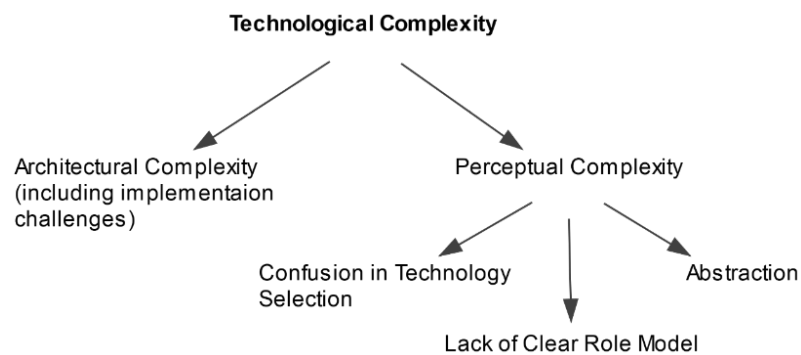
4.2.1.3.1. Technological Complexity.

Technological complexity was considered as the first technological factor hindering blockchain adoption.

The results of the analysis reveal that the perception of technological complexity has two dimensions. These sub-codes, which are divided into Perceptual Complexity and Architectural Complexity, reflect significant challenges in blockchain applications.

Figure 31

Subcodes of Technological Complexity



Based on the participants' statements, *perceptual complexity* is caused by three main factors: *confusion in technology selection*, *ambiguity at the level of abstraction*, and *lack*

of clear role models. Participants emphasized that difficulties in choosing the right technology increase the complexity of blockchain. P1 said,

"The cause of the complexity is confusion—specifically, which is the right technology to choose?" and that businesses have difficulty deciding which blockchain model to adopt

The uncertainty experienced when choosing between different business models was expressed as follows:

"What will be the winning method, what is the difference between them? For example, if I am going to buy a right-of-use watch for blockchain, do I need to use old technology or new technology? Which of these 20 different business models is more efficient in my business. The information on these is not clear." (P1, 155).

The uncertainties in the technical structure of blockchain make it difficult to understand the technology by creating *uncertainties at the level of abstraction*. P1 explained this situation as

"Too many unknowns, with parameters missing" (P1, 153).

In addition, participants stated that *the lack of a successful role model* reduces trust in blockchain projects. P3 said,

"There is already a lack of understanding. I mean, this is also the case on the private sector side, they said that the right job description needs to be done correctly. In other words, the importance of designing the system correctly, as you said, if it does not meet a certain need, it is more unsuccessful. Since these are bad examples, people don't want to attempt the project again because they are bad examples due to failure." (P3, 40).

P1, on the other hand, stated that successful role models are not sufficiently present in the sector and said,

"The scarcity of successful role models..." (P1, 153).

Architectural complexity shows that the multi-layered structure in the design and implementation processes of blockchain systems causes the technology to be perceived as complex. P2 emphasized the importance of architectural design and said,

"The R&D work we will do on the technical side is very important... How many contracts will you write? How complex will the contract be? How large is the system we're talking about? There are so many variables involved." (P2, 57).

In addition, he emphasized the importance of establishing the right architecture with the statement,

"... since it requires implementation from scratch, figuring out exactly where and how to address things and working through the architecture is by far the most challenging part in the background... the design aspect... establishing the right architecture is very important." (P2, 124-128).

The layered structure of the blockchain and the complexity of its technical details prolong the decision-making processes of those managing the project. P8 described the technology as

"Blockchain has such a multi-layered and complex structure." (P8, 56).

P1 expressed the gray areas in architectural design as follows:

"Technically, it seems very nice to be able to apply it, but gray areas emerge." (P1, 212-213).

In addition, the correct selection of *the proof mechanism* to be used in blockchain projects stands out as an important requirement. P2 stated that these structures should be carefully evaluated according to the requirements of the projects, saying,

"Why you want to build the proof mechanism, you need to start from that fiction." (P2, 173-177).

In addition, the complexity of developing and implementing *smart contracts* was also emphasized. P2 said,

"A smart contract is written once, tested, then it goes live. Here, you don't have the chance to say, 'let's make changes' like in briefs."

and stated that this process requires careful planning (P2, 23-25).

These findings reveal that the *perceptual* and *architectural complexity* of blockchain technology is among the major obstacles that make it difficult to implement projects. The multi-layered nature of the system, the establishment of the right architecture and the careful selection of the proof mechanism are critical factors for the successful implementation of blockchain.

4.2.1.3.2. Cost Concerns.

According to the results of the analysis, the second technological barrier is expressed as "Cost Concerns".

Based on the statements of the participants, it was determined that cost items such as investment costs, software development expenditures and infrastructure installation of blockchain projects make the sustainability of projects difficult.

P10 emphasized that blockchain projects require long-term and serious investments:

"It is a costly project... there is a serious investment in the project, there are projects that close in 7-8 months... It is not a 5-year failed project." (P10, 10).

Pointing out that software developers working in the field of blockchain have higher costs than normal software developers, P10 expressed the cost pressure experienced in the process of developing this technology as follows:

"The cost of software developers is also higher... higher than the cost of normal software developers." (P10, 10).

Investment payback periods are also a major concern for businesses. P2 stated that Turkish society prioritizes cost and is careful about how long it takes for investments to pay back:

"Our Turkish people usually think about the first cost. When will my investment return to me, how will it benefit me?" (P2, 15).

In addition, economic conditions also increase the financial pressure on blockchain projects. P10 stated that due to the current inflation and recession expectations, companies are trying to cut costs, which reduces the willingness to invest in long-term projects such as blockchain:

"A recession is expected in the world this year. Everyone is trying to get back on track, and if they are, they are trying to stop the project... market conditions are affecting." (P10, 17).

Infrastructure investments required by blockchain projects also stand out as an important cost item. While P5 stated that infrastructure installation costs are high, P9 expressed concerns about whether the total cost of the projects is affordable:

"Building infrastructure is expensive." (P5, 20)

"What will it cost, can we afford it?" (P9, 36).

It is therefore possible to say that high-cost requirements are a barrier to adoption.

4.2.1.3.3. Scalability Issues.

The third sub-category in the group of technological barriers to blockchain adoption is scalability issues. Participants stated that factors such as increasing transaction volume, uncertainty in the number of users in the system and the intensity of verification processes are limiting in terms of scalability.

P2 stated that the number of contracts and the size of the system increase the complexity in blockchain projects:

"How many contracts will you write? How complicated a contract are you going to write? How big a system are we talking about? There are so many variables." (P2, 57).

P10 emphasized that blockchain projects face scalability problems as they grow and that the lack of sufficient support for the technology makes this situation even more difficult:

"Since there is no deepening in the technology, the scalability problem becomes more difficult as it grows." (P10, 27).

The decentralized nature of blockchain makes verification processes more difficult as the number of users in the system increases. P11 stated the following in this regard:

"Since it is not a centralized system, verification is on-chain and the scalability in that order is much more difficult. Because we don't know if several users are connected to the system." (P11, 19).

In addition, P3 stated that high transaction volumes slow down the blockchain infrastructure and the performance remains low compared to existing databases:

"When there are too many transactions, the blockchain infrastructure can be a bit slow. When the number of transactions grows, it can be difficult." (P3, 22).

P1 stated that as the data grows, the complexity of encryption and decryption processes increases, making the scalability of the system more difficult:

"The bigger the data gets, the more things will happen... Therefore, the information that the data will be transported needs to be built in different structures." (P1, 141).

4.2.1.3.4. Technological Compatibility.

Finally, the incompatibility of blockchain technology with existing systems has emerged as an important technological barrier to adoption. Participants stated that blockchain should be integrated and interoperable with other systems.

P1 stated that blockchain technology is not only a communication tool, but also requires the existence of integrated systems in the background:

"Blockchain is not just a communication tool. Interoperability requires the integration of blockchain-related technologies in the background." (P1, 132-135).

He also stated that workflows should be coded in a harmonized manner for the successful implementation of blockchain projects.

P1 emphasized the importance of stakeholders in the ecosystem creating cooperation and harmonized working models and stated that blockchain projects should be supported by a consortium:

"The more different technologies you try to bring together, the more stakeholders need to create a revenue model and work together." (P1, 143-144).

It was also emphasized that blockchain requires a high level of automation to be effective in production and supply processes. In this context, P1 stated that dependence on the performance of third parties limits the functioning of the system:

"Since we are as strong as the weakest link, I need to strengthen the automation infrastructure of the weakest link. The transfer of sensitive contract-based data is important in this regard." (P1, 60-64).

4.2.1.4. Organizational Barriers

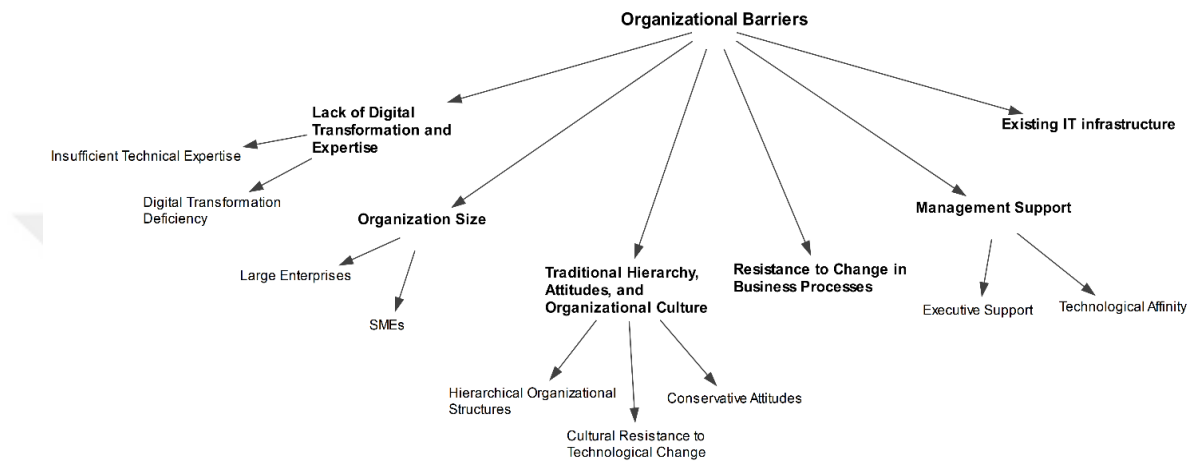
In the qualitative analysis of the barriers to blockchain adoption, the fourth main category was identified as "Organizational Barriers".

These barriers are caused by many factors, such as structural and cultural characteristics of businesses, management support and lack of digital transformation. Therefore, for in-depth analysis, these barriers were addressed with the categories of Organization Size, Lack of Digital Transformation and Expertise, Resistance to Change in Business Processes, Traditional Hierarchy, Attitudes and Organizational Culture, and Management Support.

Each category reveals which factors and which sub-factors constitute barriers to the adoption of blockchain technology, based on the statements received from the participants. Figure 32 below shows the Code and Sub-Code Hierarchy Map of Organizational Barriers.

Figure 32

Code & Sub-Code Hierarchy Map of Organizational Barriers

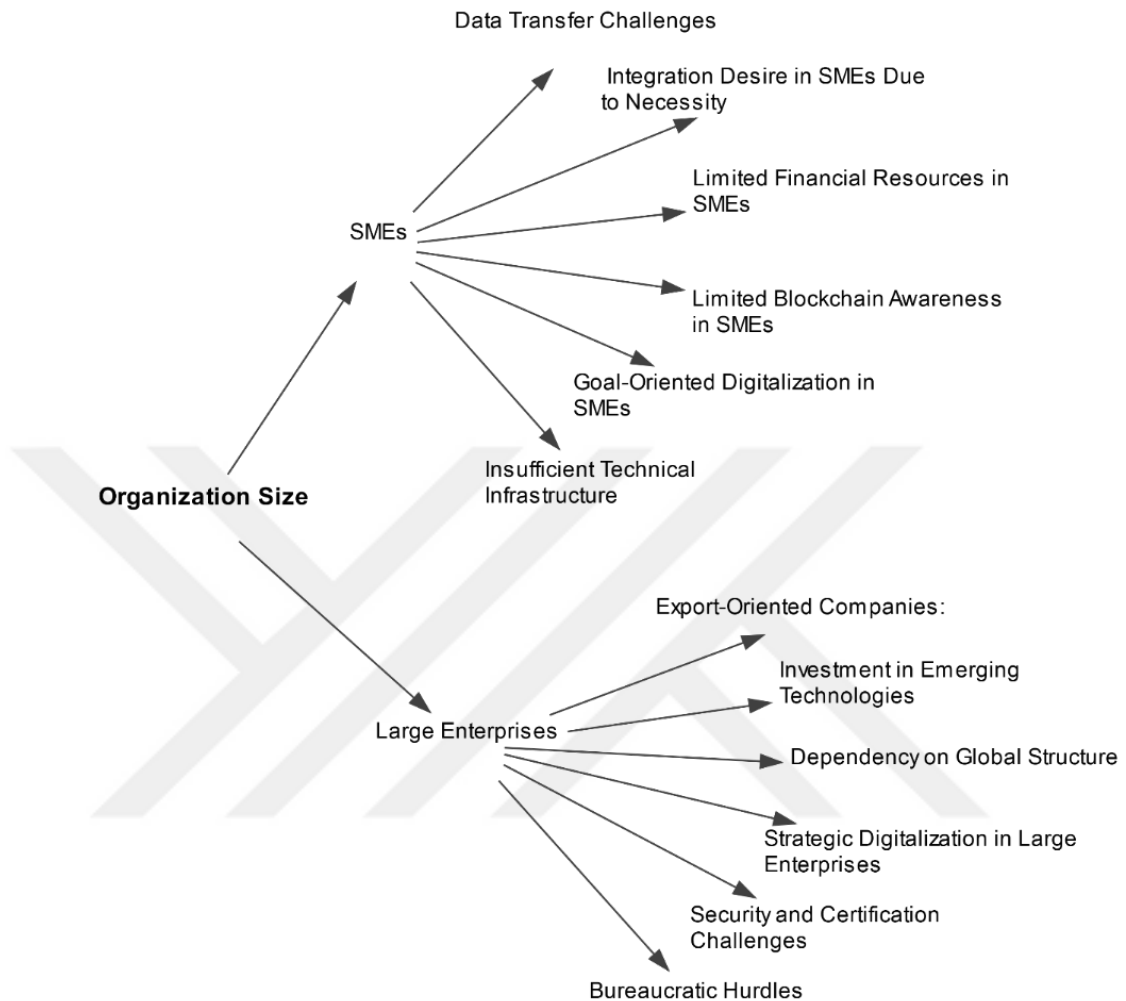


4.2.1.4.1. Organization Size.

The impact of organization size on the adoption of blockchain technology was analyzed based on participant statements, and it was found that this factor presents different barriers and opportunities in the context of both large-scale enterprises and small and medium-sized enterprises (SMEs).

Figure 33

Subcodes of Organization Size



Although the participants stated that large-scale enterprises are more advantageous in the process of adopting blockchain technology, they also stated that these enterprises face some difficulties arising from their own dynamics. It has been observed that large enterprises with high export rates have a more favorable structure in terms of technological investments. P5 expressed this situation as follows:

"As the export share increases, the capacity for technological investment grows, putting these organizations at an advantage". (P5, 8).

However, the presence of information technologies and R&D units in large enterprises increases the likelihood of investing in new technologies. P11 explained this situation with the following words:

"Large companies are investing in blockchain technology. Information technology departments, R&D units or large independent audit firms play an active role in this process." (P11, 63).

Similarly, P5 emphasized that large enterprises that invest in ERP systems are more ready for blockchain projects:

"We can say that companies that invest in ERP applications are ready." (P5, 6).

Digital transformation strategies of large enterprises often aim to optimize resource management and modernize business models. P6 explained the digitalization approach of large companies as follows:

"Very large companies are doing digitalization to facilitate the business model as a necessity of the age, it is related to resource management." (P6, 6).

However, it was also stated that global companies have difficulty in producing unique solutions at the local level. P7 expressed this situation as follows:

"Of course, we are a part of a global company in Türkiye. It can be really difficult to act independently from the whole and produce original solutions." (P7, 16).

In addition, concerns about security and certification processes in global companies may cause blockchain projects to be abandoned. P7 made the following statements in this regard:

"We experience some disadvantages of being a global company. For example, while solving our business with software that provides cloud services, some security concerns and certification issues arise. Since these processes create bureaucracy in the background, we prefer to continue the way we know." (P7, 14-15).

Small and medium-sized enterprises (SMEs) face more obstacles in adopting blockchain technology due to limited resources and lack of infrastructure. Participants stated that SMEs' approach to digitalization is generally geared towards sustaining their business. P6 stated this situation as follows:

"SMEs' approach to digitalization is goal-oriented. While they have a traditional business model, they want to be involved in it for the purpose of integration into the global platform." (P6, 6).

It was also stated that SMEs want to integrate into global systems rather than being left out. P6 explained this situation as follows:

"SMEs are willing to integrate rather than being left out because of the need." (P6, 8).

However, the lack of technical infrastructure stands out as a factor limiting the participation of SMEs in blockchain projects. P10 expressed this situation as follows:

"Other small firms couldn't participate due to lack of technical infrastructure ... they had problems sending the correct data ... working with regional systems caused issues with data transfer to the global system." (P10, 5).

It was also stated that SMEs have low levels of access and awareness of blockchain technology. P11 said the following about the situation of small and medium-sized enterprises in Anatolia:

"When we look at Anatolia, small and medium-sized companies ... don't have much access to blockchain technology. They don't even know much about it" (P11, 64).

In addition, data transfer to global systems stands out as an important problem for SMEs working with regional systems. P10 explained this situation as follows:

"Since they work with regional systems, there were problems in sending data to the global system." (P10, 5).

As a result, while large-scale enterprises have an advantageous position in the adoption of blockchain technology with their extensive resources and digital transformation capacities, they face obstacles such as bureaucracy and dependence on global structures. On the other hand, SMEs face greater challenges in adopting the technology due to their limited budgets, lack of technical infrastructure and lack of awareness. Business size-specific strategies need to be developed to overcome these differences.

4.2.1.4.2. Existing IT Infrastructure

The adequacy and compatibility of the existing IT infrastructure in the adoption of blockchain technology emerges as a significant barrier between large and small enterprises. The statements of the participants show that the deficiencies in the IT infrastructure make the adaptation process difficult, especially in small enterprises, and create compatibility problems in large enterprises.

Deficiencies in the IT infrastructure of Anatolian SMEs significantly hinder their ability to adapt to blockchain applications. As P11 highlighted, *“many companies in Anatolia could not adapt to digital transformation requirements,”* emphasizing these challenges by stating, *“although e-commerce companies and corporate firms in Istanbul have completed their transformation regarding data protection, there are still firms in Anatolia where, even at the end of 2023, when we send a commitment during trade, they still ask, ‘what is this?’”* (P11, 67).

P10 drew attention to the technical difficulties faced by small firms in sending data to global systems:

“... small firms could not participate due to insufficient infrastructure ... there was an issue with data transfer to the global system because of regional systems.” (P10, 5).

In large-scale firms, it was stated that investments in existing infrastructure may create incompatibility with new technologies such as blockchain. For example, P2 stated that some companies resist blockchain integration because they have invested in their existing ERP systems:

“... there is an ERP system in place ... I have invested in it. Why should this side benefit me ” (P2, 14).

Similarly, P2 explained the hesitations of a customer who switched to SAP during the adaptation process to blockchain technology:

“... we switched to SAP ... blockchain on the finance side ... they said it wouldn't work for us”, and that large companies stick to their existing system investments and do not look favorably on blockchain integration (P2, 16).

P5, on the other hand, highlighted that the diversity in the IT infrastructure of large companies creates adaptation challenges, stating, *“IT infrastructure is not the same ... infrastructure mismatch,”* emphasizing that inconsistencies in infrastructure are among the key obstacles to blockchain adaptation (P5, 38-42).

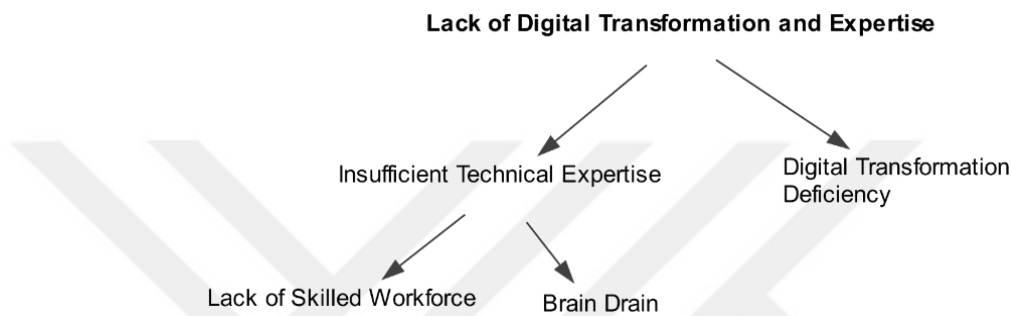
In general, the incompatibilities of the existing IT infrastructure stand out as serious obstacles in the integration process of blockchain technology for both SMEs and large-scale enterprises. While the lack of technical infrastructure creates more problems for small enterprises, large enterprises have reservations about blockchain integration due to investments in existing systems.

4.2.1.4.3. Lack of Digital Transformation and Expertise.

Digital transformation deficiencies and inadequacies in the field of expertise are among the important organizational barriers to the adoption of blockchain technology. These barriers are categorized as *Insufficient Technical Expertise and Digital Transformation Deficiency* based on participant views.

Figure 34

Subcodes of Lack of Digital Transformation and Expertise



Insufficient Technical Expertise was identified as one of the key barriers to the adoption of blockchain technology. Participants emphasized that the lack of technical knowledge directly affects the success of projects and that the need for Lack of Skilled Workforce is critical. P8 stated that blockchain teams established in the public sector are generally staffed by inexperienced people and drew attention to the lack of a skilled workforce by saying,

"... no startup project in the world has emerged from the hands of developers or those who learned later" (P8, 43-44).

The presence of experts with technical knowledge plays a decisive role in the success of projects. P10 emphasized the necessity of a multidisciplinary approach, stating *that*

"... when you work with people in IT, it is internalized. Multidisciplinary, only software developers cannot sustain it" (P10, 13).

P2, on the other hand, stated that it is impossible to work with teams without technical competence as follows:

"... at the point where there is no qualification ... writing that code will be useless ... because someone will trigger it, follow it, use it so that it has a use ..." (P2, 60).

Lack of technical staff is another factor that complicates the technology adoption process. P10 underlined the lack of both technical and financial knowledge by saying,

"There is a lack of technical people... digital literacy and financial literacy is needed for crypto" (P10, 16).

Similarly, P8 stated that a general lack of knowledge negatively affects both trust and adoption, stating that:

"... I'm not just talking about technical software knowledge ... people lack knowledge ... it impacts trust and adoption negatively" (P8, 11).

Another reason for the shortage of technical experts was explained as talented individuals going abroad. P5 expressed this situation as

"Brain drain ... will hinder digital transformation projects ... companies may not be able to find people to make software" (P5, 12).

Especially in blockchain projects that require high technical knowledge, this situation exacerbates the problem of finding experts.

Digital Transformation Deficiency was identified as another main obstacle that many businesses in Türkiye face in the process of adapting to innovative technologies. Participants stated that the discourse on digital transformation is often insufficient in practice. P12 criticized this situation with the following words:

"... all the businesses in Türkiye say we are innovative, we are digital ... but when you ask how many startups you have served ... they just stare blankly" (P12, 49-50). Emphasizing that the lack of digital transformation is a widespread problem, P5 stated that *"... the deficiency in digital transformation is very high"* (P5, 38). and expressed the inadequacies of many businesses in this area .

In general, technical expertise and digital transformation gaps in the adoption of blockchain technology are exacerbated by factors such as difficulty in finding competent personnel, lack of knowledge and brain drain. These barriers limit the capacity of businesses to adapt to innovative technologies and make it difficult for blockchain to become widespread.

4.2.1.4.4. Resistance to Change in Business Process.

Resistance to change in business processes is an important obstacle to the adoption of blockchain technology. This resistance stems from firms' reluctance to move away from their existing systems and their reservations towards innovative technologies. Concerns about compatibility, effort and perceived benefits are often at the heart of this resistance.

Participants indicated that established firms are reluctant to adopt new technologies as long as they think that their existing systems are sufficient. P1 expressed this tendency as *"If they think they can manage their business, they won't switch to any technology "* (P1, 272).

Similarly, P5 stated that many companies continue to use old customs software, *"Old companies ... have 20-year-old customs software. If it's working, they keep using it; there's resistance to change "* (P5, 42).

Another reason for resistance is comfort and familiarity with existing systems. P2 stated that customers are reluctant to consider alternatives when they are satisfied with the status quo, *"... If they give me a prototype and I'm already comfortable with what I have, I won't even bother ... so the persuasion process is really slow"* (P2, 133-135). This reluctance is further reinforced by a reservation, especially towards unknown technologies. P7 stated that

"... resistance at every stage ... comes up with technology. Because something unknown can often become a process everyone is wary of" and drew attention to the source of this reservation (P7, 15).

In addition, companies' loyalty to familiar software solutions such as ERP or SAP also causes reservations about blockchain adoption. P2 stated that some of his customers were opposed to blockchain integration after switching to SAP, *"We just switched to SAP ... finance said, 'Let's skip this blockchain part; it won't work for us"* (P2, 16). This reflects loyalty to familiar systems; P2 also stated that

"... we already have an ERP in place. I've invested in it. Why should this benefit me?", explaining the resistance created by existing investments (P2, 14).

The tendency to use package programs in foreign trade companies also reinforces this resistance. P5 stated that

"Foreign trade companies tend to use package programs " and that there is a habit against innovative technologies such as blockchain in these sectors (P5, 38). Stating that companies that invest in some applications such as ERP are ready, P5 emphasized that companies that carry out manual processes are "not ready" (P5, 5-8).

P12 stated that the innovative nature of blockchain is uncertain compared to the established solutions offered by large companies and explained the source of this hesitation by saying

"Why go for something highly innovative and unproven like crypto, when established companies like Microsoft or SAP have solutions?" (P12, 14).

4.2.1.4.5. Traditional Hierarchy, Attitudes and Organizational Culture.

Traditional hierarchical structure, cultural resistance to technological change and conservative attitudes constitutes important obstacles in the adoption of blockchain technology. These factors are *discussed under the sub-codes of Hierarchical Organizational Structures, Cultural Resistance to Technological Change and Conservative Attitudes* in line with the statements of the participants.

Figure 35

Subcodes of Lack of Traditional Hierarchy, Attitudes, and Organizational Culture



Hierarchical Organizational Structures make it difficult to adapt to decentralized technologies such as blockchain due to the centralized structures observed in the vast majority of Turkish companies. P4 expressed the negative impact of the hierarchical structure of companies on this process as follows: "... Everything, including companies' structures, is hierarchical. Even if they say they are moving to a flat organization, management is never flat; it's always at the top. So, institutions managed with centralized

structures ... It's almost impossible for them to move to a decentralized way of thinking" (P4, 27). Furthermore, the decentralized nature of blockchain leads to some resistance as it limits the control that managers have over the processes. P4 describes this as *"Everything is centralized ... any company manager controls everything in the supply chain, including the message going to the other party. But when blockchain is in place, everyone can control it simultaneously. Is management ready for this?"* (P4, 21-22). In addition, P7 emphasized the difficulties global companies face in developing local solutions, stating, *"We are, of course, a part of a global company in Türkiye. We really struggle to act independently and produce unique solutions"* (P7, 16).

Cultural Resistance to Technological Change shows the existence of cultural barriers in Turkish companies in transitioning to new technologies. P7 talked about the difficulties of convincing companies that are resistant to innovative solutions, stating that

"Having a legal basis can be a bit more convincing for companies managed with a traditional mindset. We're still trying to convince 85-year-old Japanese executives ... It can be challenging" (P7, 46-47).

P12, on the other hand, explained the low risk appetite of Turkish companies and their preference to compete in traditional ways by stating that

"The limited risk appetite of companies in Türkiye's commercial environment tends to keep competition on traditional grounds" (P12, 22).

In the case of companies in Anatolia, it is seen that the transition to innovative technologies such as blockchain is perceived as a distant goal. P11 expressed this situation by stating that

"The transition from traditional commercial methods to new technology is much harder in Anatolia. They still operate with promissory notes and checks ... Introducing blockchain is like taking them to space; they approach it with fear due to a lack of awareness" (P11, 68-69).

Conservative Attitudes refers to managers' cautious approach towards data sharing and process controls. P4 expressed the need for managers to have full control in supply chain processes as

"A company manager controls everything in the supply chain, including the message going to the other party" (P4, 21).

Such conservative approaches constitute a significant barrier to the transition to technologies that require transparency and data sharing, such as blockchain. P7, on the other hand, emphasized the reservations of the traditional management approach towards data sharing with the words

"The traditional mindset is extremely cautious about sharing information ... as if you're going to buy the company. No one wants to share their information" (P7, 34).

Consequently, overcoming such cultural and structural barriers is important to ensure a successful transition to decentralized technologies.

4.2.1.4.6. Management Support.

Management support plays an important role in the adoption of blockchain technology. This support is shaped especially by the interest of managers in technology and the commitment of senior management to the project. Management support was analyzed under the sub-codes of *Technological Affinity* and Executive Support according to the statements of the participants.

Technological Affinity refers to managers' interest in technology and their positive approach towards digitalization processes. P7, stating that they work closely with the digitalization department, emphasizes how this affinity shapes the digitalization efforts of businesses by saying, *"We even have a digitalization department in our company, and we are in close contact with this team ... We have a passion to use technology in a way that maximally adapts it to our work"* (P7, 12-13). However, it was also noted that the decentralized nature of blockchain may create concerns about loss of control for some managers. P4 questioned the effects of decentralization on managers, stating *that "Everything is centralized ... any company manager controls everything in the supply chain, including the message going to the other party. But when blockchain is in place, this kind of control is not possible ... Is the manager ready for this?"* (P4, 21-23). In addition, P2 expressed the importance of top management support for decision-making processes in blockchain projects as follows:

"Governance is an important issue in blockchain. So, it's crucial that the decision-making mechanism is in place ... if the governance structure isn't willing to do this with you and maintain that desire, it doesn't work. Due to the nature of blockchain, you can't achieve a common ground without it" (P2, 164-167).

Executive Support covers the commitment and support of senior management to the project. P4 emphasized that senior management's support for the project is a vital requirement and stated, *"If there's no top management support, this won't work "* (P4, 18). Similarly, P2 explained the active participation of senior management in projects as *"Top management says, 'Alright, I'll do this"* and emphasized the importance of high-level decision-making mechanisms (P2, 59). It was stated that due to the nature of the blockchain, strong management support to the project is required, otherwise the blockchain will have difficulty in functioning as a common platform.

In addition, the importance of extending top management support to organizational levels was also emphasized. P4 explained the impact of the support provided by the management on employees by saying *"An employee will do whatever the manager tells them to do"* (P4, 23).

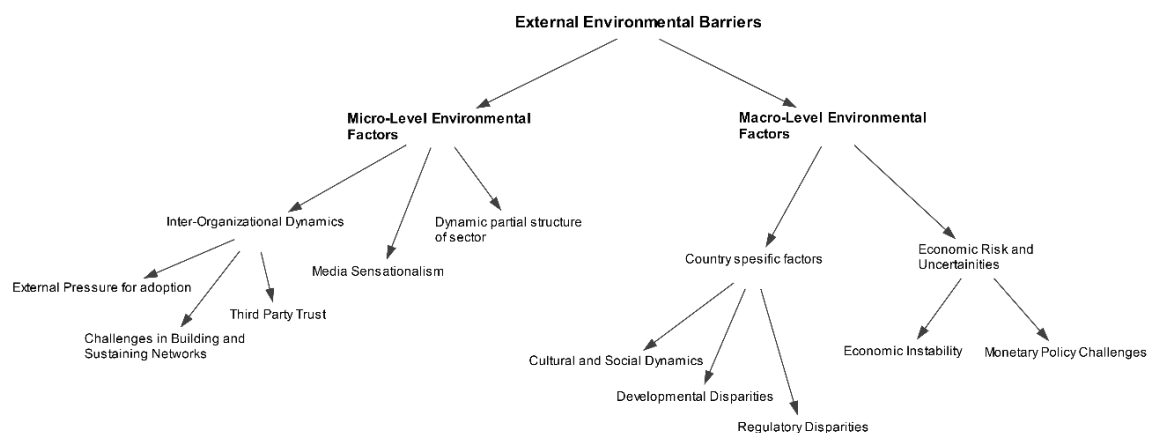
Therefore, managers' interest in technology and strong support from senior management are among the factors that accelerate the adaptation process of organizations to blockchain projects and increase the likelihood of success.

4.2.1.5. External Environmental Barriers

In the qualitative analysis of the barriers to blockchain adoption, the fifth main category was identified as "External Environmental Barriers", which includes the categories of Micro and Macro level barriers.

Figure 36

Code & Sub-Code Hierarchy Map of External Environmental Barriers

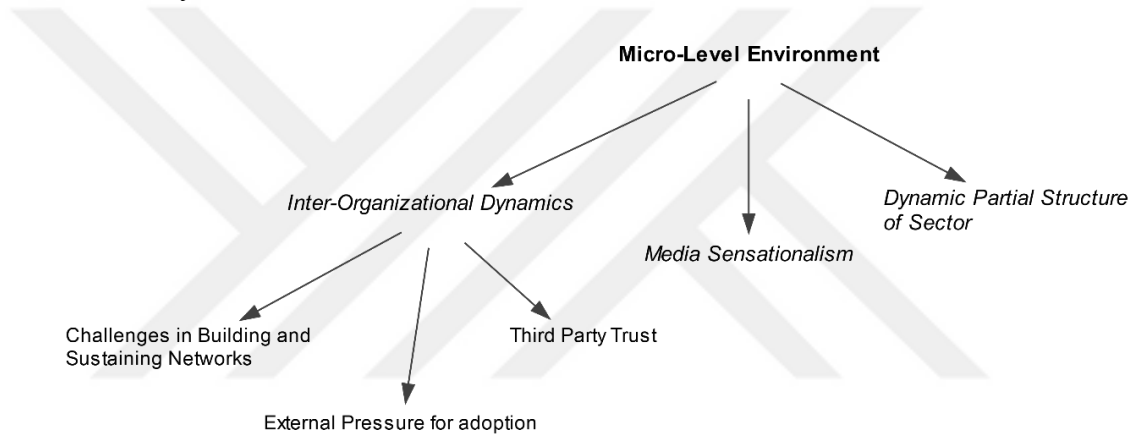


4.2.1.5.1. Micro-Level Environmental Barriers.

The findings of the qualitative analysis based on participant testimonies reveal that micro-level environmental barriers play an important role in the adoption of blockchain technology. These barriers stem from factors such as Inter-organizational dynamics, Media Sensationalism, and Dynamic Partial Structure of Sector. According to participant views, micro-level environmental barriers are classified under the headings of *Inter-Organizational Dynamics*, *Media Sensationalism*, and *Dynamic Partial Structure of Sector*.

Figure 37

Subcodes of Micro-Level Environmental Barriers



Inter-organizational Dynamics shows that inter-organizational relationships can pose significant challenges to the adoption of blockchain technology. *External Pressure for Adoption*, as an aspect of these dynamics, points out that external pressure to use blockchain can lead to unnecessary waste of resources on organizations. P3 states, "... as soon as you don't resist the pressure to use blockchain, you start using it in places that don't need it. This is a waste of resources." (P3, 6).

At the same time, *Challenges in Building and Sustaining Networks* reflects the difficulties encountered in ensuring the sustainability of blockchain networks that require multi-stakeholder structures. P3 emphasized the potential benefit of this broad participation by stating that "... the more players that come on board, the greater the added value created by blockchain", but P7 pointed out the risks to the sustainability of this process by stating that "... when one link in the chain breaks, it affects the whole process" (P7, 35). Furthermore, *Third Party Trust* shows that the lack of trusted third parties in blockchain

projects is a factor that makes adoption difficult. P1 explained that *"One of the biggest issues, as I see it, is the lack of a trustworthy third party"* (P1, 13).

Media Sensationalism reveals that exaggerated media coverage of blockchain and cryptocurrencies undermines trust in the technology. P8 stated that the false perception created by the media can negatively affect the blockchain technology by saying *"Here's the danger ... I saw on a financial news program that bitcoin yielded more than gold in 2023. If people hear about this, they'll start investing in bitcoin wildly, and if bitcoin fails, blockchain technology will take a major hit"* (P8, 55). P3, on the other hand, pointed out that sector actors have difficulty in explaining the real potential of blockchain by saying *"... No matter what you say, the media takes it and headlines it ... if you say something slightly positive, it doesn't work; if it's slightly negative, you end up having to defend the sector"* (P3, 84). These findings show that the media's objective approach is critical for the acceptance of blockchain technology.

Dynamic Partial Structure of Sector explains the impact of digitalization levels in different sectors on blockchain adoption. P5 stated that the logistics sector is ahead of the curve in terms of digitalization, but this process is slower in sectors that depend on some traditional practices, stating that *"... There are differences based on the sector. The logistics sector is in a race against time and technologically advanced, while customs brokers and exporters are stuck with traditional methods ... diversity has both advantages and disadvantages for blockchain"* (P5, 3). P6, on the other hand, emphasized that the digitalization differences between sectors should be considered in the adaptation to blockchain projects, saying *"The sector has a partial structure; the tendency towards digitalization is essential to consider"* (P6, 7).

As a result, overcoming micro-level environmental barriers requires the development of strategies that foster collaboration to support the application of blockchain in different sectors and the media's objective coverage of technology.

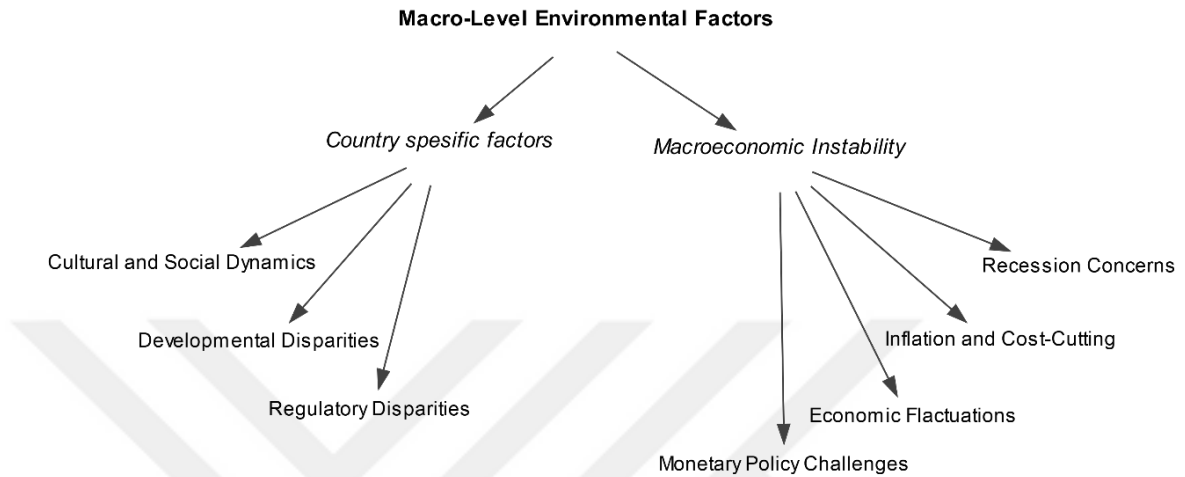
4.2.1.5.2. Macro-Level Environmental Barriers.

Macro-level environmental barriers such as country-specific factors and macroeconomic instability play an important role in the adoption of blockchain technology. These barriers include differences in the country's social, cultural and regulatory environment, as well as risks and uncertainties arising from economic fluctuations. According to the statements

of the participants, macro-level environmental barriers are analyzed under the headings of Country-Specific Factors and Macroeconomic Instability.

Figure 38

Subcodes of Macro Level Environmental Barriers



First of all, *Country-Specific Factors* are among the important barriers to the adoption of blockchain technology. *Cultural and Social Dynamics*, *Developmental Disparities* and *Regulatory Disparities* are significant sub-dimensions of these barriers.

Cultural and Social Dynamics shows that the business culture, social structure and social perceptions in Türkiye slow down the adoption of blockchain technology. The centralized management structure in Türkiye contradicts the decentralized nature of blockchain. P12 explained this as "*Türkiye's corporate management mentality stems from a hierarchical structure*" (P12, 46) and pointed out that this structure makes it difficult to adapt to innovative technologies. In addition, the low appetite for risk-taking in Türkiye's business culture was cited as another factor limiting the transition to innovative technologies. P12 summarized this by stating that "*...the business environment in Türkiye shows a low appetite for risk, with companies more inclined to compete through traditional means*" (P12, 22).

The fact that small investors see blockchain technology as a means of short-term gain makes it difficult for them to understand the long-term potential of the technology. P11 explained this trend by saying "*There is a motivation among small investors for quick access to money... especially during bull markets, they closely follow these trends*" (P11, 65-66). Moreover, the insufficient adoption of decentralized structures in Türkiye was mentioned as another important barrier. P12 explained this as "*We see the shift to*

decentralized, P2P structures not only in technologies like blockchain but also in the transformation of companies worldwide... However, this isn't something that happens overnight, and here in Türkiye, I see that we're experiencing some delays in these structural changes within businesses, which also acts as a barrier" (P12, 47-48).

Developmental Disparities shows that technological developmental disparities in Türkiye delay the adoption of blockchain technology. P8 stated that *"The Turkish people haven't even heard of Web 3 ... the world is moving to Web 3, but it naturally reaches Türkiye later"*, indicating that differences in digital development make it difficult to adapt to new technologies (P8, 60).

Regulatory Disparities reveals that international regulatory incompatibilities complicate the adoption of blockchain technology. *"In some countries, it's accepted as a form of payment, but in others, it's not ... this lack of recognition turns advantages into disadvantages,"* P11 said, highlighting the negative impact of regulatory differences on the technology (P11, 21-22).

Second, *Macroeconomic instability* shows that economic fluctuations and uncertainties in Türkiye significantly affect the adoption of blockchain technology. Economic factors such as *inflation* and *recession expectations* lead companies to cut costs and limit their investment in innovative projects. P10 explained that *"inflation, recession, high investment costs, it's a time for cost-cutting"*, indicating that economic conditions increase companies' cost-cutting efforts and this restricts investments in innovative projects such as blockchain (P10, 17). It was also stated that economic uncertainties reduce companies' appetite for risk. P12 stated that *"Economic fluctuations ... create a constant hesitation for businesses, reducing their risk appetite"* and explained how this affects the approach to technology (P12, 46).

Monetary policy challenges in Türkiye are further complicated by the growing interest in blockchains and cryptocurrencies. *"The shift to cryptocurrency creates challenges for states with their own currencies ... that's why central banks, including ours, are working on launching their own digital currencies"*, P1 noted the impact of cryptocurrencies on monetary policy and emphasized the need for central banks to develop new strategies in this area (P1, 188-189).

These findings suggest that factors such as economic instability, *inflationary pressures*, *recessionary expectations*, *economic volatility* and *monetary policy challenges* limit the adoption of blockchain technology.

4.2.1.6. Regulatory and Policy Barriers

"Regulatory and Policy Barriers" has been identified as the sixth main category that complicates the adoption of blockchain technology. Participants emphasized that regulatory uncertainties and policy barriers are key factors affecting the widespread acceptance and applicability of the technology.

As a result of the qualitative analysis, regulatory and policy barriers were analyzed under three main headings: "*Legal Uncertainties*", "*Bureaucratic Barriers*" and "*Others*". These headings detail the key factors limiting the adoption of blockchain technology.

The code-subcode model for barriers under "Regulatory and Policy" is shown below.

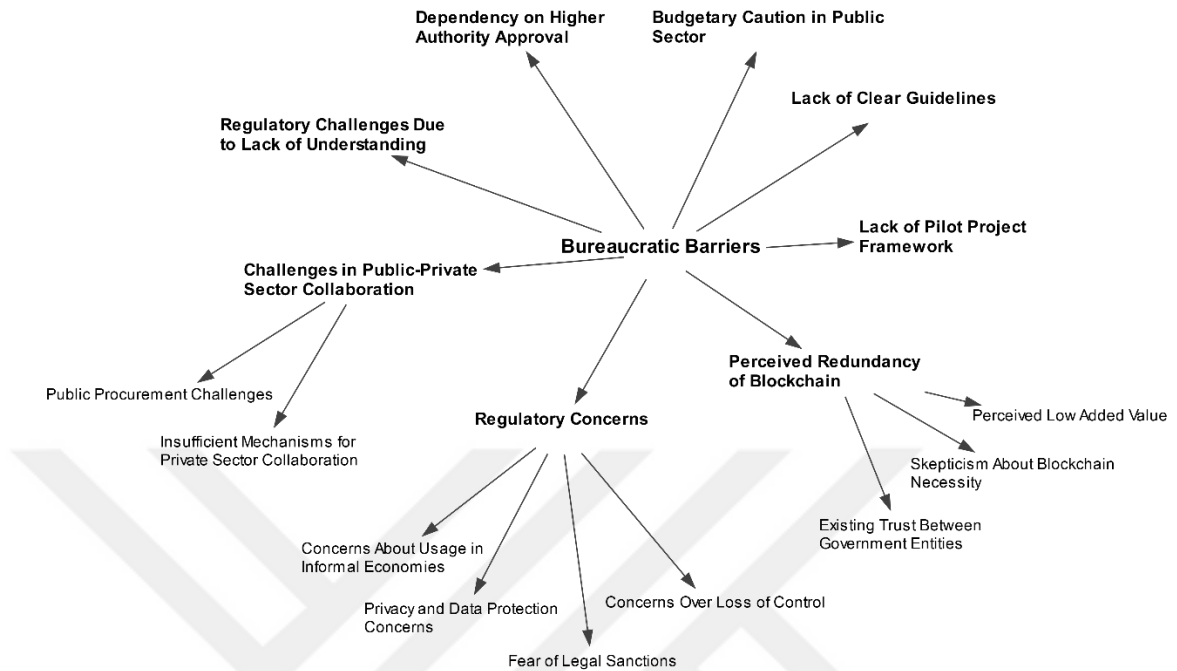
4.2.1.6.1. Bureaucratic Barriers.

Based on the analysis of participant statements, various codes and sub-codes defining the "Bureaucratic Barriers" sub-category were revealed. These codes stand out as factors that make it difficult to adopt blockchain technology in bureaucratic processes.

This sub-category was analyzed with the codes "Perceived Redundancy of Blockchain," "Challenges in Public-Private Sector Collaboration," "Regulatory Challenges Due to Lack of Understanding," "Budgetary Caution in Public Sector" and "Fear of Legal Sanctions."

Figure 39

Sub-categories and Codes of Bureaucratic Barriers



Perceived Redundancy of Blockchain refers to the perception that blockchain technology is considered redundant by some public institutions compared to existing systems. The analysis shows that this perception can be explained by the codes Existing Trust Between Government Entities, Skepticism About Blockchain Necessity and Perceived Low Added Value.

Participant P3 stated that *the Existing Trust Environment* between Government Entities makes the implementation of blockchain technology unnecessary. It was stated that the existing systems are sufficient and there is no need for the trust infrastructure offered by the blockchain with the following statements:

"When the state is involved, that trust is somehow formed." and *"It says, I am the state, I am building a database. I do not have a trust problem."* (P3, 20).

Skepticism About Blockchain Necessity in public projects also emerged as an important barrier. Participant P3 stated that he questioned whether public institutions need to use this technology as follows:

"The question of whether blockchain is necessary becomes more prominent." (P3, 20).

In addition, *Perceived Low Added Value provided by blockchain in public projects is low* is another important factor that makes it difficult to adopt the technology. Participant P3 explained this perception with the following statements:

"The government seems to me that the impact of blockchain and the added value it creates in transactions at that moment is a bit lower." and "Is there that much added value, is there a need for it? It starts to be questioned a bit on our side." (P3, 20-21).

As a result, public institutions' trust in existing systems, doubts about the necessity of blockchain and the perception of low added value stand out as the main obstacles to the widespread adoption of this technology in the public sector.

Challenges in Public-Private Sector Collaboration is another major barrier to the adoption of blockchain technology. This problem is addressed under two main headings: *"Inadequate Private Sector Collaboration Mechanisms" and "Public Procurement Challenges."*

P3, one of the participants, stated *Insufficient Mechanisms for Private Sector Collaboration* with the following words:

"The public sector doesn't have sufficient mechanisms... When the government wants to procure something, it writes up a specification, issues a tender, pays the money, and receives the service. But this approach doesn't work for blockchain... the government won't initiate a project without knowing if the technology works." (P3, 74). In addition, it was stated that public officials are distant from such projects due to the high project costs. P3 explained this situation as *"We once talked to IBM... they asked for millions for a tiny pilot project... no official would approve that without understanding the technology" (P3, 75)*

In addition, *current public procurement processes* are also inadequate to meet the demands of new technologies such as blockchain, making it difficult for public institutions to access these solutions. P3 expressed this difficulty as follows:

"We engaged with a few companies, and immediately questions arose like, 'Why are you working with these firms? Did you pay them?'... things that don't really align with the public sector mentality. That's why a mechanism is needed; the current procurement model doesn't work." (P3, 76-77).

These findings reveal how public-private partnership issues and constraints in existing procurement processes limit the capacity of public institutions to explore and implement blockchain technology.

Regulatory Challenges Due to Lack of Understanding of blockchain technology slows down the pace of adoption of this technology by public institutions. This finding, especially from the statements of P3, emphasizes that decisions taken by public institutions without sufficient knowledge about the technology can lead to regulatory challenges in the sector.

P3 expressed the need for the state to have a comprehensive understanding of the technology before making a decision.

"They need to understand the technology before making a decision... especially higher authorities like the Digital Transformation Office, to say, 'This is the technology, here's what to pay attention to, do this, don't do that' " (P3, 33).

Stating that not fully understanding the technology when making regulations can lead to both wrong decisions and excessive intervention in the market or complete abstention, P3 said, *"If you regulate the market without understanding it, it's problematic... banning it because it's not understood is also an issue... The state and relevant institutions need to understand this" (P3, 33-34).*

P3 also emphasized once again that understanding the technology is indispensable in the regulatory process,

"They need to understand and implement it accordingly... we need to understand the technology. We may choose not to regulate, but we must first understand it... especially in the public sector where blockchain, like cryptocurrencies, can be more challenging to grasp" (P3, 81-82).

Regulatory concerns that hinder the adoption of blockchain technology in the public sector are concentrated in areas such as privacy and data protection, loss of control and use in informal economies. *Privacy Concerns and Legal Sanctions* make it difficult to safely implement the technology in public institutions. P5 expressed these concerns as follows:

"There are public concerns; data privacy, money laundering." (P5, 40).

The transparent nature of blockchain creates uncertainty about how it can provide a solution in situations where data needs to be kept confidential.

Concerns Over Loss of Control also constitute an important dimension of regulatory reservations. The decentralized nature of blockchain increases the fear of public institutions to lose their existing control mechanisms. This was expressed by P5 as follows:

"The public does not want to lose control." (P5, 30).

This new structure, which is outside the understanding of control based on a central authority, slows down the speed of technological adoption by public institutions.

In addition, *Concerns about usage in informal economies* also stands out among the regulatory challenges. In this context, P5 drew attention to activities such as money laundering, stating:

"There are public concerns; data privacy, money laundering." (P5, 40).

Such concerns illustrate the impact of regulatory shortcomings on public institutions regarding the misuse of blockchain.

In this context, uncertainties around privacy and data protection, fear of loss of control, and the risk of use in informal economies stand out as the main regulatory barriers that hinder the adoption of blockchain technology in the public sector.

In addition, *Fear of Legal Sanctions* and budgetary caution by the public sector are among the factors that negatively affect the adoption of blockchain technology. Concerns about the legal consequences of processes based on data sharing limit the use of this technology in the public sector. Participant P5 expressed this situation as follows:

"As soon as such technology is involved in data sharing, everyone does something extra. They hesitate, because many of these things are tied to court cases, so they can be the subject of very serious lawsuits." (P5, 40).

Such legal reservations about data sharing cause the technology to be seen as risky and public institutions to keep their distance from blockchain applications.

Budgetary caution in the public sector also stands out as an important barrier limiting investment in new technologies such as blockchain. It was stated that public institutions are hesitant to spend large amounts of public resources on unknown and new

technologies. Participant P3 expressed this by stating that the public sector has a cautious approach towards expenditures that are outside its current *modus operandi* as follows:

"This approach isn't well-received... we engaged with a few companies, and immediately questions arose like, 'Why are you working with these firms? Did you pay them?'" (P3, 76). Furthermore, emphasizing the hesitation of public officials to allocate budget for new technologies, P3 stated, *"A public official wouldn't spend this money on unfamiliar technology"* (P3, 75).

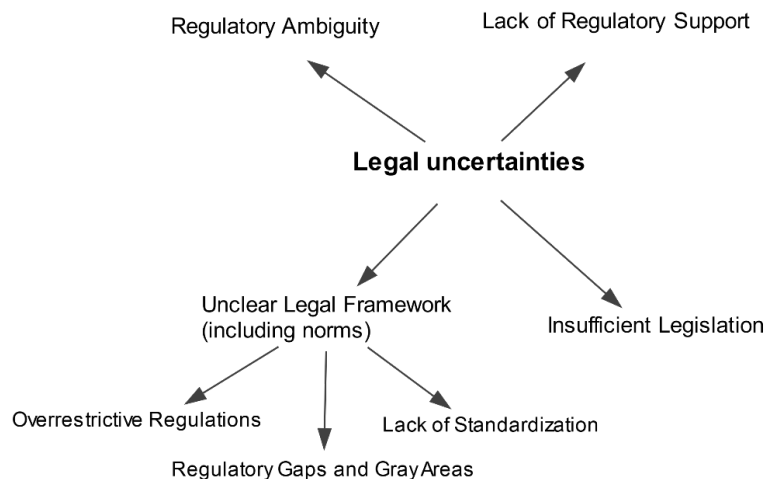
These findings suggest that hesitancy to invest in new technologies in the public sector makes it difficult to adopt innovative solutions such as blockchain and limits innovation processes.

4.2.1.6.2. Legal Uncertainties.

Legal uncertainties are one of the main obstacles affecting the adoption of blockchain technology. *Unclear Legal Framework, Regulatory Ambiguity, Insufficient Legislation and Lack of Regulatory Support* were analyzed with sub-codes.

Figure 40

Sub-categories and Codes of Legal Uncertainties



The Unclear Legal Framework was cited as an important factor limiting the development of blockchain technology. Participants emphasized that *over restrictive regulations* have a negative impact on innovation. P12 described this situation as follows:

"... let's regulate in such a way that no one can move an arm. There cannot be such a regulation. There cannot be prohibitive regulation" (P12, 33). In addition, the lack of

standardization has emerged as another important factor limiting the proliferation of blockchain. P10 expressed this need as *"there should be standardization in terms of data"* (P10, 31). P12, who stated that the gray areas created by the lack of regulation are not appetizing, used the following statements:

"...the insufficiency of regulations and the gray areas discourage ambition." (P12, 22).

Regulatory Ambiguity is another important factor that limits the applicability of blockchain projects, especially in the public sector. It was stated that public institutions are cautious even to pilot projects due to the lack of legal framework. P3 emphasized how the lack of legal clarity affects projects by saying, *"...when tech and data sharing are involved, people hesitate because... these can lead to serious legal cases. Especially in the public sector, they wait for someone to say, 'You can use blockchain for this, or you can't' ... Without this framework, they just stop"* (P3, 35-36).

Similarly, P8 stated that regulatory uncertainty slowed down the progress of projects by saying:

"Almost all major corporations, banks in Türkiye set up blockchain teams years ago... they eventually slowed down due to regulatory reasons" (P8, 22).

Insufficient Legislation stands out as another important obstacle that directly affects sectoral practices and public projects. P9, one of the participants, emphasized the inadequacy of the legislation by stating that *"... these are not practiced in the sector ... there are issues such as electronic recording of negotiable instruments. These need to be regulated"*, emphasizing the inadequacy of the legislation (P9, 40).

This deficiency is considered as a fundamental barrier to the development of blockchain applications in the public sector.

Lack of Regulatory Support was identified as a critical need to accelerate the adoption of blockchain technology. Participants stated that investments in the technology are costly and that infrastructure deployment requires high expenditures. In this context, P5 emphasized the importance of government support, stating that *"Companies need support for digital transformation... as blockchain transactions increase, incentives could come from the Ministry of Trade, banks, and customs"* (P5, 20).

P6, on the other hand, stated that regulatory support should be provided by public institutions, stating that *"There is a need for encouragement from public institutions..."*

there are still documents that need development on paper. The government should take the lead" (P6, 4-5). In addition, it was emphasized that regulatory support is not limited to financial incentives, but also requires a deep understanding of the technology and efforts to develop strategic solutions to expand the infrastructure. P10 explained this necessity as follows:

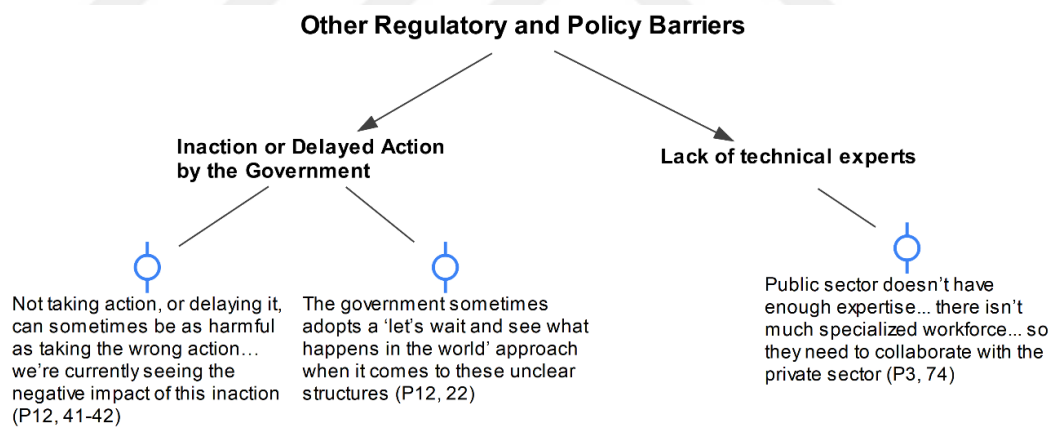
"People cannot get the necessary support from the institution, from the state. They cannot deepen in technology. They cannot deepen how complex it is and what is needed. After deepening, there is a scalability problem. It gets harder as it grows." (P10, 27).

4.2.1.6.3. Others Regulatory and Policy Related Barriers.

Based on the analysis of participant testimonies, other regulatory and policy barriers that hinder the adoption of blockchain technology include *Lack of Technical Experts* and *Inaction and Delayed Action by the Government*.

Figure 41

Sub-codes and Excerpts of Other Regulatory and Policy Barriers



Lack of Technical Experts in public institutions emerges as an important hindering factor in the adoption of blockchain technology. P3, one of the participants, stated that the public sector is insufficient in understanding new technologies and that this deficiency makes cooperation with the private sector mandatory: *"Public sector doesn't have enough expertise... there isn't much specialized workforce... so they need to collaborate with the private sector (P3, 74)."*

The passive attitude of the government towards innovative technologies (Inaction and Delayed Action by the Government) is another important barrier limiting the adoption of blockchain. P12 stated that the inaction of the government delays the widespread adoption

of the technology as follows: *"Not taking action, or delaying it, can sometimes be as harmful as taking the wrong action... we're currently seeing the negative impact of this inaction"* (P12, 41-42).

Similarly, P12 criticized the government's approach to innovative technologies such as blockchain, saying, *"The government sometimes adopts a 'let's wait and see what happens in the world' approach when it comes to these unclear structures"* (P12, 22).

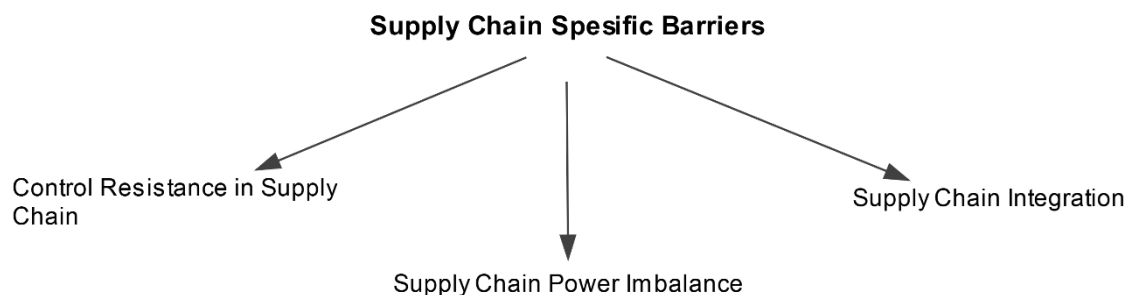
These findings suggest that the lack of technical expertise of public institutions and the government's passive attitude towards innovative technologies are also among the major regulatory and policy barriers that slow down the adoption of blockchain technology.

4.2.1.7. Supply Chain Specific Barriers

The seventh main category of blockchain adoption barriers was identified as *Supply Chain-Specific Barriers*. The qualitative analysis findings show that many of the barriers affecting the adoption of blockchain technology also negatively affect supply chain processes in general. However, the barriers addressed in this category include only those that are specific to the supply chain. In this context, three main unique barriers stand out that make it difficult to adopt blockchain technology in the supply chain: *Control Resistance in Supply Chain*, *Supply Chain Power Imbalance* and *Supply Chain Integration*.

Figure 42

Sub-categories of Supply Chain Specific Barriers



4.2.1.7.1. Control Resistance in Supply Chain

Managers in the supply chain resist the adoption of blockchain technology due to concerns about losing the control they have over data and processes in existing systems.

One of the participants, P4, stated that the transparency and sharing mechanisms brought by blockchain do not match with the current management habits:

"In a supply chain, every manager controls everything... but with blockchain, there's no such single control. Everyone can access the control simultaneously. Is the manager ready for this?" (P4, 21-22).

This statement shows managers' reluctance to share control is an important factor limiting the adoption of blockchain technology.

4.2.1.7.2. Supply Chain Power Imbalance

The strong positions of large players in supply chains reduce the necessity and applicability of blockchain technology. P1, one of the participants, gave an example from the automotive sector in Türkiye and explained this situation as follows:

"In Türkiye, Tofaş is one of the companies that can use BCT, but Tofaş is such a big company and its subcontractors and sub-industry are so poor... Tofaş determines everything from its costs to how much it earns. Now, in such a dominant structure, blockchain is extremely unnecessary. When this sub-industry gets stronger, unites... then it starts to set the rules itself." (P1, 106-111).

This statement reveals that in supply chains where there is a power imbalance, the advantages of transparency and equality brought by blockchain are not in demand.

4.2.1.7.3. Supply Chain Integration

The successful implementation of blockchain technology requires the integration of all components of the supply chain. However, when any link in the supply chain is missing or incompatible, this can affect the entire process. P7 explained this situation as follows:

"When one link in the chain is broken, the whole process is affected. Now our air conditioner production, for example, consists of 150 parts. 149 of them have passed, one of them has not passed to the blockchain. The uncertainty about that one may render all 149 parts unusable." (P7, 35).

This statement emphasizes that the applicability of blockchain technology is directly linked to the integration of all stakeholders into the system.

These findings clearly reveal the specific barriers that limit the adoption of blockchain technology in the supply chain context. Although all other barriers indirectly affect supply chain processes, especially managers' resistance to sharing control (Control Resistance in Supply Chain), supply chain power imbalance (Supply Chain Power Imbalance) and integration challenges (Supply Chain Integration) stand out as the main factors that directly hinder the widespread adoption of blockchain technology in this area. Overcoming these obstacles can only be possible with comprehensive strategies that will take into account not only the dynamics specific to the supply chain, but also the needs of the wider ecosystem, and cooperation mechanisms that will ensure the participation of all stakeholders.

4.2.2. Interview Findings II: Recommendations and Strategies

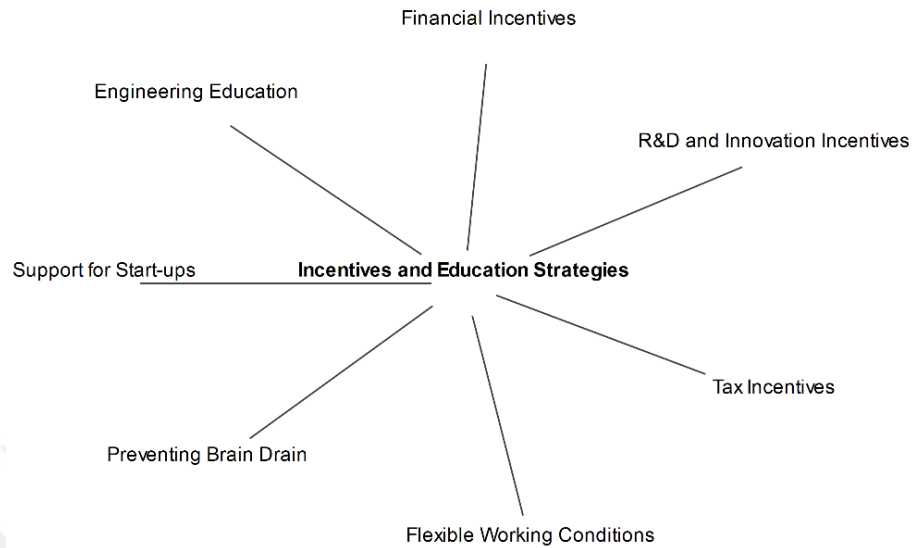
This section discusses the suggestions and strategies offered by the participants in order to accelerate the adoption of blockchain technology, overcome existing obstacles and ensure more widespread use of the technology. The recommendations are grouped under seven main categories: *Incentives and Education Strategies*, *Information and Perception Management Strategies*, *Innovative Approaches and Project Development Strategies*, *Innovative Trials and Pilot Programs Strategies*, *Regulation and Legislation Strategies*, *Strategies for Role and Responsibilities of the State*, and *Transition and Compliance Strategies*. Each category covers a variety of solutions ranging from raising awareness about technology to improving legal regulations, from strengthening technical infrastructure to incentivizing businesses. These suggestions, which are based on participant statements, will be explained in detail in this section, supported by the findings of the qualitative analysis.

4.2.2.1. Incentives and Education Strategies

Incentives and education are seen to play an important role in the adoption of blockchain technology. Participants emphasized the importance of financial incentives, education and human resource development strategies, prevention of brain drain and start-up support and made various suggestions in these areas.

Figure 43

Incentives and Education Strategies for Blockchain Adoption



Participants stated that *financial incentives* are a facilitating factor for businesses to invest in blockchain technology. One participant stated that the state could contribute to the adoption of this technology by providing incentives to enterprises as follows: *"I mean, the state can say, if you are doing such R&D studies, I deduct the money you spend here from your taxes."* (P12)

Another participant stated that incentives are important in terms of reducing the costs of companies and facilitating their orientation towards new technologies:

"It would be useful to have incentives, for example, this incentive is how companies already work. When companies do something new, they don't do things that are beneficial to the society, they don't do it on their own to be beneficial to the society. The only aim of companies is to make profit. They do it in the shortest way possible to make a profit." (P4)

Education and human capital development stand out as another factor affecting the adoption of blockchain technology. Participants emphasized the importance of education and human capital development. One participant stated that traditional programs for engineering education are inadequate and that these programs need to be improved: *"Education needs to be improved. Traditional programming language, traditional university curricula are used in engineering. These need to be improved."* (P5) In addition, it was stated that making working conditions

in technopolises *more flexible* would be beneficial in terms of keeping talented employees in the sector:

"R&D centers, technopolises, places where work on new technologies is carried out are under the Ministry of Industry. If controls were made flexible, engineers would not move to other companies. These companies become advantageous in competition. It would be advantageous if working conditions were made flexible and not bound by legislation." (P5)

Preventing brain drain is another issue highlighted in the adoption of blockchain technology. Participants stated that increasing the level of national prosperity can reduce brain drain. One participant expressed this situation as follows: *"Brain drain is a national problem. The company's earnings are related to income; if the national welfare level increases, migration will decrease."* (P5)

The importance of *start-up support* in the development of blockchain technology was also emphasized. One participant expressed this situation as follows:

"Startups should be supported. The blockchain ecosystem survives as long as it builds a good ecosystem." (P10)

This suggestion shows that start-up support can be an effective tool in promoting technological innovation.

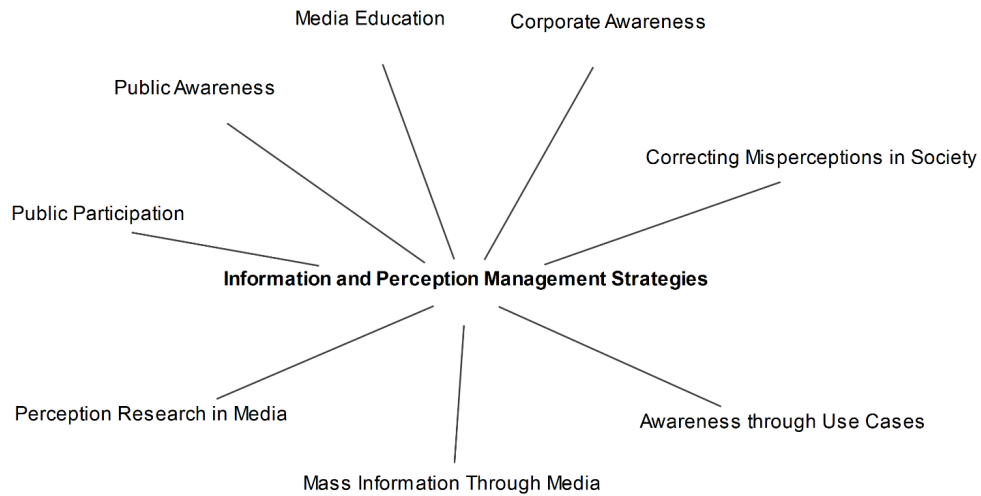
In conclusion, the findings of the qualitative analysis reveal the importance of incentives, training, improving working conditions and start-up support to accelerate the adoption of blockchain technology.

4.2.2.2. Information and Perception Management Strategies

It was emphasized in the qualitative analysis findings that information and perception management is important in the process of dissemination and adoption of blockchain technology. Participants drew attention to issues such as *increasing institutional awareness, informing the public and correcting misperceptions*.

Figure 44

Information and Perception Management Strategies



It was stated that in order for blockchain technology to be adopted, first of all, *corporate awareness* should be created. Participants emphasized the importance of raising awareness of companies about the benefits of this technology in the medium and long term. For example, one participant expressed this situation as follows:

"The most important thing is to raise awareness in companies, especially on the corporate side, about how this will benefit them in the medium and long term. For example, I always say this in the projects we talk about. We need to do something with an event that we can do institutionally in the company, we need to raise awareness first." (P2)

Another participant stated that lack of awareness is one of the biggest obstacles to the adoption of blockchain technology as follows:

"Commercial customs are very different. For example, while there is still a commercial life based on checks and promissory notes, the other side may perceive blockchain technology as if you are suddenly taking it into space. Therefore, without this awareness, they approach it with fear." (P11)

These statements show that training programs and awareness-raising activities to be organized at the institutional level can play a fundamental role in the widespread adoption of blockchain technology.

It was stated that *public awareness should be increased* in order for the blockchain technology to be better understood by the public. A participant who stated that the public should have more information about this technology expressed this situation as follows:

"The blockchain needs to be explained in a way that the public can understand, and it needs to be a warrior." (P10)

It was also stated that local applications can support this process. For example, one participant stated that making popular systems such as Istanbul Kart blockchain-based could raise awareness:

"If it supports an initiative that is easy to be used by the public, for example, for example, Istanbul Kart, that is, if Istanbul Kart's blockchain base works." (P8) These findings show that local applications and public information activities can increase interest in technology.

Correcting misperceptions has emerged as a critical element in the adoption of blockchain technology. Participants stated that the media does not provide accurate information about blockchain technology and this leads to misunderstanding of the technology. One participant expressed this situation as follows:

"Well, my suggestion is to correct the perception in the media, I have never come across any perception research in the media. But I think there is a big deviation there. First we need to educate the media. I am very sincere, if we correct the perception in the media, if the media understands what to report and what not to report, people will be much better informed." (P8)

Another participant stated that the unbalanced transfer of positive and negative information in the media negatively affects social perception as follows:

"It was not the central bank, there was this working group on crypto. Maybe this team gathered for 2-3 months and there were people from all public institutions. We couldn't do the following: We were trying to make a press release, but we couldn't. Because if you say something positive, people immediately pile on cryptocurrency." (P3)

These statements reveal the necessity of training media organizations and providing accurate information to the public.

It was also stated that *awareness should be raised with real use cases* to ensure understanding of blockchain technology. One participant stated that individual efforts are not enough in this regard and strategies to create mass awareness are needed as follows:

"This is not something that can be developed through individual or platformal efforts. It

is not something that can be developed in universities and high schools. People need to be massively informed by media and use cases." (P8)

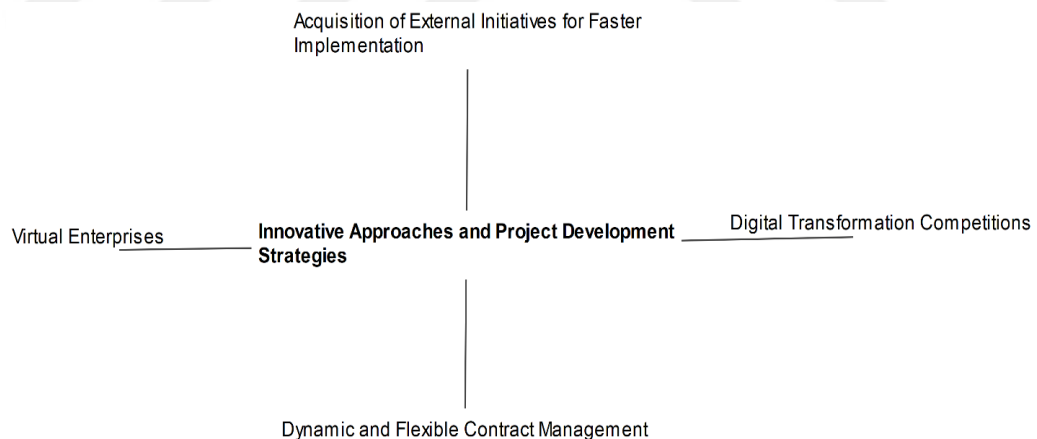
In conclusion, the findings of the qualitative analysis reveal that knowledge and perception management plays a key role in the mainstreaming of blockchain technology. In addition to awareness-raising activities at the institutional and societal level, participants stated that correcting media perception and informational strategies based on real use cases are effective approaches to support the adoption of the technology.

4.2.2.3. Innovative Approaches and Project Development Strategies

Innovative approaches and project development methods were highlighted by participants as an important strategy to accelerate the adoption of blockchain technology. Under this category, several suggestions emerged, such as *rapid integration of external initiatives*, *digital transformation competitions*, *flexible contract management* and *the use of virtual business models*.

Figure 45

Innovative Approaches and Project Development



It was stated that *external initiatives should be integrated into existing systems* for faster implementation of blockchain projects. It was stated that governments and large organizations can accelerate their transition to technology by collaborating with or incorporating external innovative initiatives. One participant expressed this as follows:

"They prefer to develop with their own teams. However, if they bring in external initiatives through merge acquisitions, direct acquisitions, they will come up with use cases much faster." (P8)

Another participant stated that it is insufficient to leave projects solely to the management of technical teams and that innovative ideas should be outsourced:

"I know many of the members of the blockchain team that was set up on the public side and is still working today very closely. They taught blockchain to these people. So these people learned blockchain. Then they started coding. But no startup project in the world has ever come out of the hands of developers or later learners. You need a business idea first." (P8)

These statements show that the integration of external initiatives is an important factor in bringing innovative ideas into the system and accelerating projects.

Organizing *digital transformation competitions* to support innovative ideas related to blockchain technology was presented as a solution proposal in project development processes. One participant explained the benefits of these competitions as follows:

"Now we tried to overcome it like this. I did a project, for example, we did a project called 'digicamp'. It was a competition. Digital transformation competition, that was its only purpose. Its sole purpose was to make a general announcement with the logic of a competition without a tender and put forward our needs, we need such and such a project for you to understand about the blockchain. Let the companies come, let them present it to us, let us reward the one we like, and then it becomes a real project." (P3)

This approach is considered as an effective tool to overcome the slowness of traditional tendering processes and to realize innovative projects quickly.

It was emphasized that *flexible and dynamic contract management* should be developed in blockchain-based systems. Particular attention was drawn to the shortcomings related to smart contracts and their integration into business processes. One participant made the following statements in this regard:

"One of the parts of the business that is not emphasized much at the moment is contract management. The contract negotiation part, as applications related to contract negotiation develop, these models may increase. In other words, the transformation of blockchain contracts into a workflow is one side of this." (P1)

The same participant explained how smart contracts should be developed according to today's business needs as follows:

"But there is a saying that contracts are for a rainy day. That's why, for example, when you look at a contract with a bank, you feel small. There are so many bad, disturbing

things... Now, apart from these things, the more the models of how that contract will bring agreements, regulations, etc. according to the conditions of the day are studied, the more commercially accepted it will be." (P1)

These findings suggest that flexible contract management and smart contract systems offer a significant opportunity for more effective management of blockchain-based business processes.

Virtual businesses and blockchain-based supply chain models were considered as an innovative approach. Participants stated that the rapid setup and dispersal characteristics of such businesses are compatible with blockchain technology. One participant explained this situation as follows:

"It is for virtual enterprises to create supply chains. Because there is such a situation: A government has changed in South America, Latin America. There was a coup. 500 new deputies came and these 500 new deputies want a gold-plated car. You want to bid for this as Fiat, for example. This needs to be standardized so that these virtual enterprises can be established and disbanded quickly until the project is finished." (P1)

This finding suggests that virtual business models can offer an effective solution, especially in projects that require speed and flexibility.

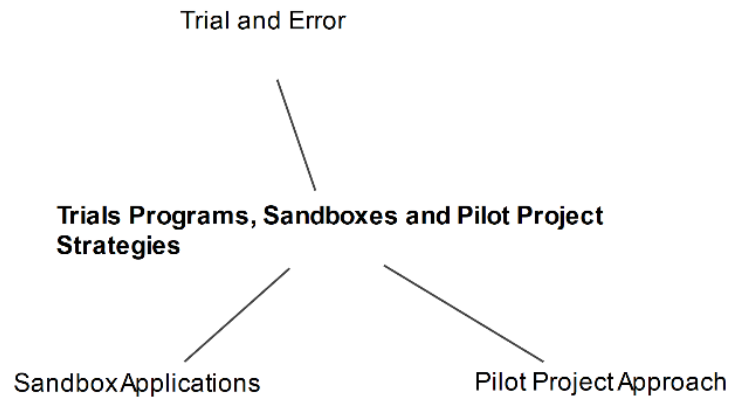
In conclusion, the findings of the qualitative analysis reveal that the integration of external initiatives, digital transformation competitions, flexible contract management and virtual business models offer innovative and effective strategies in blockchain projects. These approaches have significant potential to accelerate technology adoption and optimize business processes.

4.2.2.4. Trials Programs, Sandboxes and Pilot Project Strategies

It was pointed out that *trial programs* and *pilot projects* can also play an important role in the adoption of blockchain technology. Participants stated that staged pilot projects, sandbox applications and trial-and-error are effective strategies to test the applicability of the technology and facilitate the adoption process.

Figure 46

Trials Programs, Sandboxes and Pilot Project Strategies



Participants stated that pilot projects are useful for testing the impact of technology in different areas and solving problems encountered in implementation. One participant explained this method as follows: *"For example, in the public sector, maybe not in the private sector, but there are not many in the public sector. We call it pilot implementation, they say in the market, they say this, for example, this logic does not exist in the public sector."* (P3)

Another participant expressed the benefit of small-scale projects as follows: *"It is not to start with a huge, huge project, but to choose a pilot and build on that pilot and scale a small project, that is, to phase it."* (P2)

These findings show that pilot projects carried out with a phased approach can produce more sustainable results in the transition to large-scale implementations.

Sandbox applications are another strategy that allows new technologies to be tested in a controlled environment. Participants stated that sandbox environments are effective both for public institutions to understand the technology and for startups to comply with regulations. One participant expressed this approach as follows: *"They want a sandbox. The public understands this from the relevant public institution in that sandbox: Look, these are my regulations, these are my legislation. You need to adapt to these things. And the company explains the effects of its own technology."* (P3)

Another participant expressed the impact of sandbox practices on innovation as follows: *"If the regulations are to be strict and harsh, sandbox environments must be provided so that this does not constitute an obstacle. If this environment is provided to businesses and startups, we will walk in 2-3 years."* (P12)

These statements suggest that sandbox environments help both entrepreneurs and public institutions to understand and test new technologies.

Trial-and-error method was evaluated as an approach to understand the applicability of technological innovations in blockchain projects and to support development processes. Participants stated that trial and error facilitates making mistakes and learning from these mistakes. One participant explained this method as follows: *"We are talking about an experimental field. These experimental fields may not always produce the desired results, but it is very difficult to predict this in advance. You need to see this in the field."* (P12)

Another participant stated that even failures offer valuable learning opportunities as follows:

"Most of the blockchain projects are very valuable every single work done to provide solutions, even if it fails, you learn something new." (P10)

These findings suggest that trial and error is an important tool for increasing the applicability of technology and developing innovative solutions.

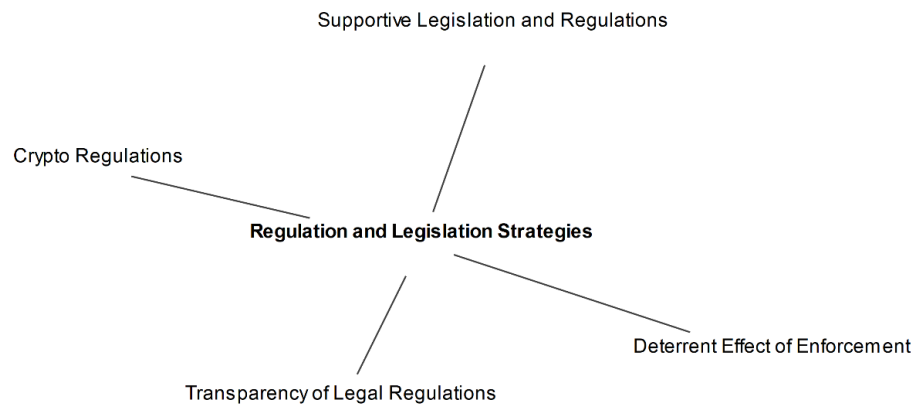
In conclusion, the findings of the qualitative analysis reveal that pilot projects, sandbox applications and trial-and-error methods are effective strategies to accelerate the adoption of blockchain technology. These methods are considered to enable secure testing and development of the technology.

4.2.2.5. Regulation and Legislation Strategies

The importance of *Legislation Strategies* and *regulations* in the adoption of blockchain technology was expressed by the participants. The elimination of uncertainties, transparency of regulations and the establishment of a supportive legislative framework were highlighted as the main requirements for the successful progress of this process.

Figure 47

Regulation and Legislation Strategies



One participant drew attention to the lack of transparency in the regulations with the following words:

"We have heard that the draft law prepared to overcome this obstacle has some problems in itself. Because it is not made publicly available." (P12)

These findings suggest that the creation of regulations that are both open and transparent is a critical factor in technology adoption.

Participants stated that a safer market can be created thanks to *the deterrent effect of legal regulations*. Stating that legal sanctions have a confidence-building function, a participant said the following:

"Having sanctions also makes the market more reliable. Is regulation necessary for it to be more reliable? Actually, of course not. But the element of trust is unfortunately very open to abuse in human relations, and when you regulate it with criminal sanctions, at least you are regulating the market." (P11) This finding emphasizes the importance of legal regulations in terms of deterrence and trust building.

Standardization and framework regulations are necessary for the application of blockchain technology in different areas. Participants stated that the lack of regulation slows down progress in the sector. One participant explained the impact of regulations as follows:

"Government imposition, legislative regulation, partial transition is required. After this process, these will be used in logistics. If blockchain-supporting legislation emerges

within the framework of the legislative infrastructure that makes this possible, the perception will change." (P6)

In addition, the importance of public institutions eliminating uncertainties by drawing a general framework was also emphasized.

"I am not saying in terms of whether to regulate or not, but in terms of understanding and some relevant and responsible institutions need to be active in terms of drawing a framework for the general public." (P3)

In addition, it was stated that regulations should be guiding and encouraging innovation rather than merely setting limits:

"The only regulation in this field in Türkiye so far is a disaster, that is, it blocks innovation. It says you cannot do this job. However, what is expected from regulation is not a prohibitive approach to not doing a job. It should be determining the framework on how to do that work." (P12)

Findings that *supportive regulatory* arrangements would contribute to the development of technology were prominent. Participants emphasized that regulations should be structured in a way that encourages innovation rather than merely setting limits. One participant expressed this situation as follows:

"Innovation-oriented development-oriented regulations that are not obstructive are needed." (P12)

Another participant stated that regulations should pave the way for innovation with the following words:

"I mean, I'm not saying incentive, I mean, don't shadow me, I don't ask for anything else. It needs to be paved the way. What is it? That is to eliminate uncertainties and encourage innovation." (P12)

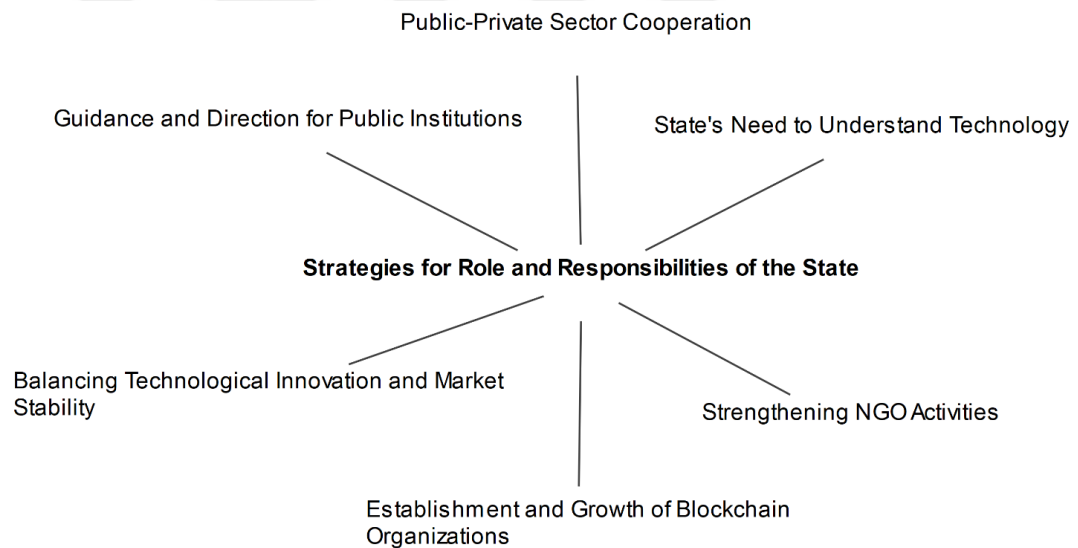
In conclusion, the findings of the qualitative analysis show that legal and regulatory frameworks play an important role in the adoption of blockchain technology. Regulations need to be created in a structure that removes uncertainties, builds trust and encourages innovation. Moreover, the regulatory framework should be transparent and inclusive to meet the needs of all stakeholders in the sector. It is recommended that public institutions take an active role and support technology through innovative regulations.

4.2.2.6. Strategies for Role and Responsibilities of the State

The role and responsibilities of the state in the adoption of blockchain technology occupies an important place in the qualitative analysis findings. Participants stated that the state should fulfill its duty to encourage technological innovation and maintain market stability. *Balancing technological innovation and market stability* was described as a complex process for the state. One of the participants said, "It is very difficult for the state to strike that balance when technology is involved. You know, let's not prevent innovation, but let's not harm the stability of the market, this is an extremely difficult thing, this applies to every sector, blockchain is also valid." (P3). This statement clearly demonstrates the need for balancing policies when the state approaches new technologies.

Figure 48

Strategies for Role and Responsibilities of the State



It was also emphasized by the participants that the state has the duty to *guide and raise awareness of public institutions*. Public institutions need to understand blockchain technology and develop appropriate strategies. One participant expressed this need by saying, "Someone needs to understand this technology and tell public institutions, look, this is this technology, pay attention to this, do this, don't do that." (P3). These findings show that public institutions need the right guidance mechanisms.

Providing institutional support for the development of the blockchain ecosystem stands out as another responsibility of the state. Participants stated that this support can be provided through both public institutions and non-governmental organizations.

"Blockchain Türkiye platform organization, Türkiye Informatics Foundation, Blockchain Europe, such as private institutions or state-sponsored organizations to increase." (P10). In addition, the role of non-governmental organizations in this process was also emphasized:

"I think NGOs should also have a say here. We should not expect everything only from the state. These processes can be accelerated with the activities of NGOs." (P12)

These statements reveal the importance of the state supporting the technology ecosystem in cooperation with non-governmental organizations.

Participants frequently emphasized the need for *public-private sector cooperation*. It was stated that the state benefiting from the knowledge and experience of the private sector would increase the success of blockchain projects. One participant said, "The public sector does not have enough now. We never have a very private sector. Its human capital is needed to understand this new technology, be it artificial intelligence or blockchain. Then it needs to cooperate with the private sector." (P3), emphasizing the necessity of this cooperation. Another participant said, "Public officials do not come up with ideas. Therefore, business developers should closely follow the blockchain projects of external initiatives and let them in, saying that this will produce such added value in our process." (P8), emphasizing the importance of integrating external innovative projects into public processes. These findings show that public-private sector cooperation plays a critical role in the success of blockchain projects.

The need for the state *to understand technology and develop appropriate policies* was also mentioned by the participants. "I think the state has a role and obligation in such developing technologies. It should not stay away from those technologies and it should understand them." (P3) clearly expressed this necessity. In addition, attention was drawn to the negative effects of regulations made without understanding the technology: "It is troublesome to do the same thing if you directly regulate and regulate the market without understanding it, it is troublesome to prohibit it because it does not understand it, it is also troublesome to say that I will not get involved because it does not understand it, look after yourselves, let the market do what it does." (P3) These findings point to the importance of the state adopting a knowledge-based understanding in its approach to technology.

The qualitative analysis reveals that the state plays a key role in the adoption of blockchain technology. The government's balancing of innovation and the market,

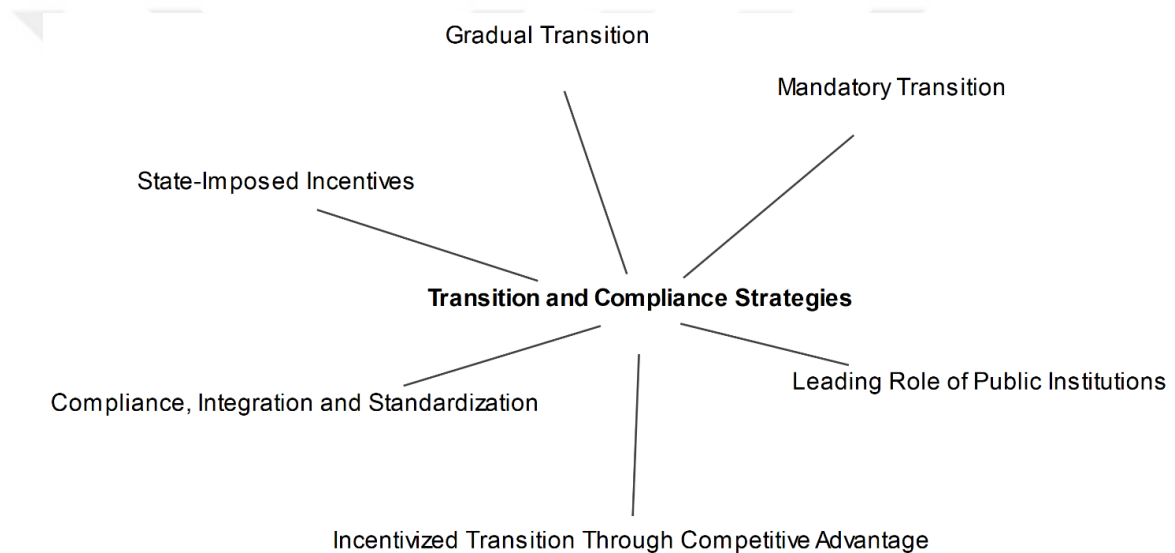
directing public institutions, cooperating with the private sector and understanding the technology are the main requirements for technology adoption. Accordingly, it is recommended that the state should take an active role, make innovative regulations and cooperate with all stakeholders in this process.

4.2.2.7. Transition and Compliance Strategies

Transition strategies and compliance processes were evaluated by the participants as important issues in the adoption of blockchain technology.

Figure 49

Transition and Compliance Strategies



In this process, it was stated that *Compliance, integration and standardization* approaches support the successful implementation of the technology. One of the participants expressed the negative impact of incompatibilities caused by different systems on businesses as follows: "I invoice 50 companies. You all have different e-reconciliation systems. I don't want to pay for all of these different things all at once. When it comes to adapting to technologies, I mean, this is the system I use. If I use another system other than this system, I will charge you money." (P1) These statements show that the establishment of standards can increase harmony among enterprises. Another participant stated that the lack of standards directly affects the system performance and said, "Right now, if one application is missing, the system does not work fully on this system." (P1). These findings reveal that regulation and standardization is a fundamental requirement for technology adoption.

Gradual transition was highlighted as an effective strategy for technology adaptation. Participants emphasized the importance of taking small steps rather than making large-scale changes all at once. One participant supported this approach by saying, "A partial transition is necessary" (P6). Another participant explained an example of gradual transition in digitalization processes as follows: "Here is an example to encourage digitalization: Export declarations are now digital only. It became hybrid from paper and then mandatory digital. It is integrated into the information system." (P5) These statements suggest that gradual transition can facilitate the harmonization process and reduce costs.

Incentive-driven transition reveals that especially government support is an important tool in accelerating the transition to technology by both the public and private sectors. One of the participants expressed this by saying, "It can also come in the form of incentives" (P12). Another participant explaining the effect of incentives on lack of knowledge said, "Lack of knowledge already prevents you from thinking. It already causes you to think wrong, but if you are incentivized, if the state incentivizes you, you will suddenly learn." (P4), emphasizing the importance of incentives, especially in areas such as financial support, education and infrastructure investments.

Mandatory transition strategies were evaluated as an effective method to achieve rapid results in technology adoption. Participants stated that the government making certain practices mandatory through regulations can accelerate technology adoption. One participant explained this process's impact: "This should be a necessity. Now, if you leave it to a choice, it will take time. Why does it take time? Tomorrow one day a company will come out. In order to gain an advantage in trade, in order to increase trust, they say, I am doing it this way. After that, and in a transparent way, look at my consumer, I offer a safe environment." (P12) Another participant expressed the role of legal regulations in mandatory transition as follows: "With legal regulations, you force exporters to declare to the customs broker, incentives need to be forced." (P5) These findings reveal that forced transition strategies have an accelerating effect on technology adoption.

Qualitative analysis findings show that different strategies should be applied together in the adoption of blockchain technology. Regulation, integration and standardization, gradual transition, incentive-driven approaches and forced transition methods stand out as effective tools for technology adoption. It is understood that these strategies should be

evaluated together to increase the speed and effectiveness of technology adoption. In particular, the state's support of this process through incentive mechanisms and regulations can play a facilitating role in the adaptation process.

4.3. Discussion

By integrating the quantitative and qualitative findings of the research, this chapter aims to understand the key dynamics of blockchain technology adoption in SCM. The quantitative findings present the ranking of factors derived from the data from the expert surveys, while the qualitative analysis findings provide in-depth insights into the reasons and context behind these factors. The discussion first focuses on the comparison and synthesis of the findings obtained through these two methods, and then considers their consistency with and differences from the existing literature, including the variables introduced in the Turkish context in addition to the literature.

4.3.1. Comparison and Synthesis of Quantitative and Qualitative Findings

In this section, the quantitative and qualitative findings of the research are analyzed together. The quantitative ranking analysis based on the expert opinion survey shows that organizational factors are prioritized over other factors in the blockchain adoption process. Accordingly, benchmarking and synthesis are primarily addressed in the organizational context, followed by noteworthy findings on individual, environmental, and technological contexts.

In the *Organizational Context*, *Executive Support* (RII: 0.91) and *Technological Affinity at the Managerial Level* (RII: 0.85) were among the top three factors with the highest degree of importance among all factors, without any classification according to respondent type. Similarly, in the qualitative analysis, the critical role of executive support in the blockchain adoption process was explained under the codes *Technological Affinity* and *Executive Support*. The executives' interest in technology, their positive attitudes towards digitalization and the active support provided by senior management to the projects contribute to the acceleration of the adaptation process. The statements of the participants revealed that blockchain projects cannot be successfully implemented without the support of senior management. This situation points to the necessity of a support structure that starts from the top levels of management and extends to all levels

of the organization. The commitment of senior management to the projects increases the participation of employees in these processes and their trust in the projects.

Qualitative findings also suggest that managers may sometimes be concerned about loss of control in adapting to the decentralized nature of blockchain technology. This highlights the importance of a strategic perspective on how to balance management support with the nature of blockchain technology. On the other hand, in the context of technological proximity, managers' interest in technology and how they integrate this interest into projects plays a decisive role in increasing the level of organizational readiness.

Again, in terms of organizational factors, according to the quantitative analysis results, "Organizational Readiness" ranked second (RII: 0.87), "Lack of Technical Knowledge" ranked tenth (RII: 0.81), and "Lack of Technology Readiness" ranked eleventh. These factors stand out as significant barriers affecting blockchain adoption at the organizational level. The qualitative analysis findings align with these results and provide more in-depth insights, especially on the lack of digital transformation and insufficient technical expertise.

Qualitative findings show that the lack of technical knowledge plays a decisive role in the success of projects and that this lack is exacerbated by inexperienced staff, insufficient digital literacy, and brain drain. Participants emphasized that the inclusion of qualified technical experts in projects is critical and that this shortage slows down the adaptation process. For example, one of the participants stated that blockchain teams often include inexperienced people, which negatively affects the success of projects. Brain drain was identified as another important factor that makes this process even more difficult. Participants stated that it is difficult to access sufficient human resources in software development and innovation projects due to the fact that talented individuals tend to go abroad.

In qualitative analyses, the lack of digital transformation occurred as another obstacle that limits businesses' adaptation capacity to innovative technologies. Participant statements reveal that although many businesses in Türkiye make ambitious statements about digitalization, they have not made enough progress. Failure to implement digital transformation initiatives prevents businesses from taking full advantage of technological transformation and makes it difficult to adopt innovative technologies such as blockchain.

In the quantitative analysis, the "*Resistance to Change in Business Processes*" factor ranked thirteenth (RII: 0.79). This result indicates that firms' reluctance to adapt to innovative technologies and their dependence on existing systems make the blockchain adoption process difficult. Qualitative findings support this conclusion and reveal that resistance to change is caused by factors such as deep-rooted habits, the perception that existing systems are sufficient, and hesitation toward innovation.

Participants stated that especially well-established companies hesitate to adopt new technologies, believing that existing systems are sufficient to sustain their business processes. The fact that some companies continue to work with 20-year-old legacy software was cited as a concrete indicator of resistance to change. This attachment to familiar systems was more prevalent among firms that preferred established solutions such as ERP or SAP. Participants stated that investments in existing systems hinder the adoption of innovative technologies such as blockchain.

In addition, *hesitation towards unknown technologies* constitutes another important dimension of resistance to change. Participants stated that the lack of knowledge or uncertainty created by innovation increases firms' reluctance to consider alternative solutions. This was attributed to both a reluctance to move out of the comfort zone of existing systems and a lack of understanding of the potential benefits of innovative technologies.

The tendency towards packaged programs in foreign trade companies also limits the adoption of innovative solutions such as blockchain. In these sectors, the reliance on established systems has emerged as a hindering factor in seizing the opportunities that new technologies can bring. On the other hand, firms with manual processes are not ready for such innovations and find it difficult to deviate from their existing processes.

The fact that the *organizational culture* variable ranked 28th in the blockchain adoption process in the quantitative analysis based on expert opinions indicates that this factor is considered a low priority. However, qualitative findings reveal that organizational culture is a significant barrier affecting the adoption of blockchain technology, especially in the Turkish context. This contradiction shows that the issue is too contextual and deep to be addressed only through a quantitative analysis.

Qualitative analysis revealed that factors such as traditional hierarchical structures, *cultural resistance to technological change and conservative attitudes* make it difficult

for Turkish businesses to adapt to decentralized technologies such as blockchain. Participants emphasized that hierarchical organizational structures are prevalent in Turkish companies and that these structures create resistance to the transition to decentralized processes. For example, one participant noted that management structures are often centralized rather than horizontal, which triggers a fear of loss of control among managers. This fear clashes with the inherent necessity of blockchain to make processes transparent and collective.

Cultural resistance is another noteworthy dimension in the approach of Turkish enterprises to technological change. Especially in Anatolian enterprises, blockchain adoption is perceived as a distant goal. In a context where business processes are still conducted in traditional ways, blockchain technology is perceived as an abstract concept rather than a realistic solution for many businesses. Low risk appetite for innovative solutions and a preference for traditional competitive strategies make this resistance even more difficult to overcome.

Conservative attitudes reflect businesses' cautious approach to issues such as data sharing and process control. Especially at the management level, the idea of outsourcing business information and the loss of centralized controls creates serious reservations. Participants emphasized that the traditional management approach is closed to such innovations and this makes the adoption of technologies such as blockchain significantly difficult.

In this context, the impact of organizational culture on blockchain technology stems from Türkiye's unique ways of doing business, cultural dynamics and conservative approaches. Considering this factor as a low priority variable in the quantitative analysis does not mean that we can ignore the contextual importance of this barrier. On the contrary, the qualitative findings make it clear that organizational culture is a strategic factor that needs to be addressed for blockchain technology adoption. This finding suggests that not only technical competencies but also cultural transformation strategies are critical for the adoption of decentralized technologies.

According to the expert opinions, *the organization size* variable was ranked 48th and considered to be of relatively low importance. However, qualitative findings show that organization size leads to a significant divergence in the adoption of blockchain technology. The nature and size of the barriers faced by large-scale enterprises and small and medium-sized enterprises (SMEs) differ.

Large-scale enterprises are generally more advantageous in investing in blockchain technology due to their large resources, information technology departments and R&D units. High export rates increase the capacity of these enterprises to make technological investments. However, *dependence on global structures*, difficulties in developing unique solutions at the local level, and bureaucratic obstacles arising from security certification processes complicate the process of implementing blockchain projects of large-scale enterprises.

Small and medium-sized enterprises (SMEs) face different challenges. Their digital transformation efforts are often focused on survival and competitiveness, but their limited technical infrastructure and low level of awareness limit their participation in blockchain projects. SMEs, especially in Anatolia, are at a disadvantage in the adaptation process due to their limited access to these technologies and lack of knowledge. Dependence on regional systems, problems in data transfer and lack of integration into global systems are other factors that make it difficult for these enterprises to take part in blockchain projects.

While quantitative analysis points to organization size as a relatively low priority, qualitative findings highlight the contextual importance of this variable. While large enterprises struggle with the complexities of global systems despite their resource and capacity advantages, SMEs struggle even at a basic level due to limited infrastructure and lack of knowledge. This clearly demonstrates the need to develop customized strategies for blockchain adoption based on business size. Tailored solutions that address the different needs and barriers of businesses will support wider adoption of this technology.

In the individual context, Perceived Benefit (RII: 0.87) and Perceived Ease and Effort Expectation (RII: 0.84) emphasize individuals' attitudes towards technology and their critical role in the adoption process of blockchain technology. While perceived utility shapes individuals' motivation to use blockchain technology, perceived ease and effort expectancy stands out as a factor that determines the feasibility of this motivation.

Perceived benefits in the adoption of blockchain technology stand out as an important variable in understanding the value of the technology for users and organizations. According to the results of the quantitative analysis, this factor ranked 12th among the individual factors. This indicates that the potential benefits of the technology are not sufficiently clarified and this has a negative impact on the adoption process. The findings of the qualitative analysis reveal that the uncertainty of perceived benefits is due to a

number of factors such as *lack of need for the technology, limited practical examples, simulation inadequacies and lack of knowledge-awareness*.

According to the results of the qualitative analysis, one of the most important factors shaping the perceived benefits of the technology is that the benefits are not clearly defined for businesses and individuals. When the benefits of blockchain technology cannot be concretized in terms of cost and return on investment, this uncertainty slows down the adoption process. Likewise, the evaluation of the technology in the wrong use cases prevents the potential benefits from being clearly identified. This leads to a lack of appreciation of the value of blockchain when applications that are not in line with the nature of the technology are pursued.

The immaturity and uncertainties of the technology were also discussed as other important factors that negatively affect the perceived benefits. Since blockchain is a relatively new technology, it is not yet mature enough. This creates hesitation, especially in the business world, and makes organizations hesitant to invest. Moreover, the lack of limited practical examples and simulation tools makes it difficult to build concrete evidence that can demonstrate the potential benefits of blockchain. This lack leads to uncertainties in the process of understanding the functionality and value of the technology.

The lack of knowledge and awareness leads to the fact that the capabilities and advantages of blockchain technology are not fully understood by a wide audience. This limits the perception of the benefits of the technology at both the individual and organizational level. In particular, lack of basic knowledge of the technology makes understanding the benefits and the adoption process more complex.

In addition, the expectation of perceived ease and effort in the adoption of Blockchain technology is an important factor shaping individuals' attitudes towards the technology. In the quantitative analysis, this factor was found to be highly significant among the individual variables and stood out as an effective factor in the adoption process. However, the results of the qualitative analysis show that the perceptual and architectural complexity of the technology is an obstacle that slows down the adoption process.

The perceptual complexity of technology stems from the uncertainties users experience in choosing the right technology and deciding between business models. The diversity of blockchain technology and the uncertainty of different use cases reduce individuals'

confidence in the technology. Confusion about choosing the right technology is a particular problem for individuals and organizations that lack experience in blockchain projects. This, coupled with the lack of successful role models, further reduces potential users' interest in blockchain projects.

Architectural complexity arises from the multi-layered structure of blockchain systems and the difficulties of their technical details. Wrong choices during the design of the system can lead to the failure of projects. For example, choosing the right proof mechanism and carefully developing smart contracts play a critical role in the success of projects. In addition, the layered structure and technical requirements of blockchain make it difficult to adapt at the organizational level.

The results of the qualitative analysis indicate that perceived complexity can be reduced through training and information sharing, and can increase users' and organizations' confidence in the technology. In order to facilitate the adoption of blockchain technology, strategies to reduce the level of perceived complexity should be developed. These strategies include increasing the number of successful projects and role models, developing user-friendly interfaces, setting standards, and creating training programs to overcome the lack of technical knowledge. These approaches can accelerate the adoption process by increasing the confidence of individuals and organizations in the technology and enable blockchain technology to be adopted by a wider user base.

When the noteworthy results in the environmental context are evaluated, **Regulatory and Policy barriers** stand out as an important factor in both quantitative and qualitative analyses. According to the quantitative analysis results, "Regulatory Support" ranked first in the environmental factors group and ranked 4th in the cumulative ranking. "Regulatory Environment Uncertainty" ranked 8th in the cumulative ranking, emphasizing the impact of the uncertainties of the regulatory framework on the adoption process. The qualitative analysis findings not only supported these results but also elaborated on the deeper contexts of regulatory barriers and their impact on public-private partnerships, bureaucratic structures and the legal framework.

In the qualitative analysis, regulatory barriers were examined under two main headings: uncertainty of the legal framework and bureaucratic barriers. The uncertainty of the legal framework makes it difficult to adopt blockchain due to both the gray areas created by incomplete regulations and the overly restrictive approaches of regulators without

understanding the technology. Lack of legislation and lack of standards are among the key factors limiting the viability of projects. Qualitative findings show that regulatory uncertainty has a negative impact on the approach to pilot projects, especially in the public sector. This suggests that the development of the technology is slowed down by both regulatory shortcomings and unnecessary restrictions.

Bureaucratic barriers stem from factors such as public institutions' perception of blockchain as unnecessary, cooperation difficulties with the private sector, budget caution and fear of legal sanctions. In public institutions, there is a common perception that blockchain does not create additional value due to the perception that existing systems are sufficient. This perception leads to questioning the need for the trust infrastructure offered by the technology and the rejection of projects. Moreover, the lack of cooperation mechanisms between the public and private sectors makes the adoption of new technologies even more difficult. The complexity of public procurement processes and high project costs prevent them from adapting to innovative technologies such as blockchain.

In addition to regulatory uncertainties, the findings of the qualitative analysis show that the lack of technical expertise in public institutions and the government's passive attitude towards technologies make the adoption of blockchain projects even more difficult. The lack of understanding of blockchain technology by public institutions leads to wrong decisions or an overly hesitant approach in the regulatory process. This situation stands out as a structural obstacle that limits the development of the technology.

As a result, in both analyses, regulatory and policy barriers emerge as a multifaceted barrier affecting the adoption of blockchain technology.

In the environmental context, among the "Pressure" factors, Trade Partner Pressure, Competitive Pressure and Industry Pressure ranked 2nd, 3rd and 5th in the quantitative analysis and 5th, 6th and 8th in the cumulative ranking, respectively. These results suggest that pressures from the external environment and competitive dynamics are important factors that increase the interest in blockchain projects. However, the findings of the qualitative analysis revealed that these factors were not explicitly emphasized, but only indirectly supported in limited contexts.

In the qualitative analysis, it is seen that the participants mentioned the popularity of technology and the necessity to adapt to global systems. This reflects the efforts of

especially large companies to adapt to technological trends under competitive pressure. For example, some participants stated that blockchain could be used in the wrong places due to its tendency to become popular. The fact that technology is only on the agenda to catch up with trends creates additional obstacles, such as the inability to accurately define needs.

The need for global companies to respond to the expectations of the international structures they are affiliated with was also mentioned in the qualitative analysis. Participants stated that the digital transformation strategies of global companies aim to optimize resource management and modernize business models. However, it was emphasized that decisions taken at the global level make it difficult to produce unique solutions in the local context. The necessity to adapt to global systems stands out as a factor that increases the motivation of large enterprises to get involved in projects.

Small and medium-sized enterprises (SMEs) are affected by environmental pressures in a different context. The desire of SMEs to integrate into global systems in order not to be excluded from them increases the interest in blockchain projects. However, their limited resources and lack of technical infrastructure make it difficult for them to realize this ambition. Participants stated that SMEs' digitalization efforts are generally aimed at sustaining their business and that they see integration into global platforms as a necessity to gain competitive advantage.

In conclusion, environmental pressures are important for competitive advantage and business continuity for both large enterprises and SMEs. While quantitative analysis emphasizes this importance, qualitative analysis shows that pressures are more often associated with technological adaptation and the effort to catch up with trends.

In terms of factors that are less important in quantitative analysis, some factors affecting the adoption of blockchain technology are discussed in more depth in qualitative analysis. Variables such as scalability, money laundering and privacy concerns, energy consumption, sustainability, lack of experimentation and feedback, cultural differences, market dynamics, and network development challenges emerged as significant barriers to implementation in the qualitative analysis.

The issue of scalability was associated with the increasing volume of transactions and the number of users making verification processes difficult. Participants indicated that system size and data density increase complexity and negatively impact the performance of

projects. Although it appears to be of lower importance in the quantitative analysis, scalability was considered a critical element due to the practical challenges faced in large-scale projects.

From a regulatory perspective, *money laundering and privacy concerns have been among* the key factors complicating the adoption of blockchain technology. The fact that its transparency-providing structure creates uncertainties regarding the protection of data that should remain confidential has increased the risk of misuse in informal economies. This leads to a cautious approach towards blockchain projects, especially in the public sector.

Sustainability and energy consumption have been linked to the environmental impacts of blockchain technology. The fact that verification processes require high energy consumption and contribute to carbon emissions has led to criticism in terms of economic sustainability, especially in crypto mining activities. While some respondents believe that these concerns are exaggerated, criticism of energy efficiency is an important factor limiting the adoption of the technology.

Lack of experimentation and feedback leads to a lack of demonstration of tangible benefits in blockchain projects. The lack of simulation tools and examples of successful implementations has reduced confidence in the technology and delayed adoption.

Cultural differences and market dynamics have been among the key factors affecting the adoption of blockchain projects in different regions and sectors. The cooperation culture and harmonization problems required by multi-stakeholder structures weaken the trust in projects. Market dynamics are associated with the limited capacity of technology to adapt to economic environmental factors.

Network development challenges are directly linked to the coordination of multi-stakeholder structures. Participants noted that benefits can increase with the size of the network, but this process is not without risks. The lack of trusted third parties emerged as another important factor complicating the sustainability of the network.

As a result, these factors, which were less significant in the quantitative analysis, were explained in more depth with the contextual dimensions provided by the qualitative analysis and were found to pose significant barriers to the adoption of blockchain

technology. It is clear that not only technical improvements, but also social, cultural and environmental barriers need to be addressed to accelerate the adoption of the technology.

The results of the quantitative analysis reveal that *security and privacy concerns* in the adoption of blockchain technology *differ according to the participant profile*. While the variables "Privacy Concerns" and "Security Risk" were identified as the top two factors with the highest importance for regulators and practitioners, they were deemed to be of lower priority for the private sector and academics. These differences point to contextual variations in the perception of these factors. Qualitative analysis findings deepened the quantitative results by revealing that security and privacy concerns are not only technical, but also perceptual and cultural factors.

According to participant statements, security concerns stem from perceptions about data sharing inherent in blockchain technology. In particular, reservations about the confidentiality of financial data and trade secrets increase the need for security protocols. Participants emphasized that there is a contradiction between the transparency offered by decentralization and traditional data protection habits. In addition to data security, misperceptions about transaction information have also been a major concern in the industry. These perceptions lead to the misconception that all system users will be able to see information that only the transaction parties need to know, which increases hesitations to adopt the technology.

Privacy concerns stem from the fact that blockchain technology does not clearly define which information will be transparent and which information will remain private in data sharing processes. Participants stated that uncertainties regarding data privacy weaken the trust of companies and users in the technology. In particular, the risk of not being able to protect trade secrets and critical information stands out as another important factor that makes technology adoption difficult. However, although privacy concerns can be addressed through perception management, users need more training and awareness raising on this issue.

Data reliability is another point of contention due to the decentralized nature of blockchain technology. Participants stated that uncertainties about the accuracy and reliability of the data stored on the blockchain cause firms to be cautious in adopting this technology. It was stated that the decentralized data structure weakens the firms' perception of control over the data and this leads to a loss of trust. In addition,

uncertainties regarding the transparency of verification processes on blockchain are another factor that undermines users' trust in the technology.

In addition to security and privacy concerns, the complexity of certification and bureaucratic processes related to the use of blockchain technology creates an additional challenge in the adoption process. The length and cost of these processes have discouraged some firms from adopting the technology. Moreover, the absence of a central authority has led to increased regulatory uncertainty, which has become a deterrent factor for users.

In the analysis of the adoption of blockchain technology, the priorities given by academics to certain variables provide important clues about the way the participants in this group evaluate the technology. In quantitative analyses, the most important factor for academics was "Organizational Readiness", followed by factors such as "Resistance to Change," "Compatibility," "Blockchain Transparency" and "Cost Concerns". These priorities show that academics focus on the basic concepts of technology, compliance requirements and financial sustainability. Qualitative analysis revealed the contextual depth of these factors, detailing technological, cultural and organizational barriers.

The compatibility of blockchain technology with existing systems is an important factor emphasized in both quantitative and qualitative findings. While academics consider technological compatibility as a critical requirement, qualitative analyses detail the challenges in achieving this compatibility. In particular, the integration of blockchain with other systems and ensuring cooperation between stakeholders are among the key requirements for the successful implementation of the technology. Participants stated that this process is not only a technological transformation, but also a cultural transformation that requires collaboration, open sharing and openness to democratic processes. This reflects a paradigm shift that requires blockchain to operate in a "community mindset".

Cost concerns are another factor prioritized by academics. Qualitative analyses describe in detail the challenges arising from the high investment costs of blockchain projects, infrastructure expenditures and software development processes. These costs are not only limited to technical infrastructure, but also affect the sustainability and turnaround time of projects. It was also emphasized that macroeconomic conditions such as economic uncertainties and recession reduce the willingness of businesses to invest in blockchain projects. Participants expressed the importance of cost-benefit analysis in these projects

and the tendency of Turkish businesses to focus on initial costs. This may lead to a lack of understanding of the long-term strategic benefits of blockchain projects.

The transparency requirements of blockchain technology and the associated challenges were also noted in both quantitative and qualitative analyses. While academics emphasize the advantages of transparency offered by blockchain, qualitative findings show that this transparency creates some reservations about organizational resistance and data sharing. In particular, conservative management approaches are said to be at odds with transparency requirements for fear of data sharing and loss of control. This situation causes the decentralized nature of blockchain technology to clash with traditional centralized management habits.

"Blockchain Mindset" stands out as an important concept in the approach to blockchain technology in qualitative analysis. Qualitative analysis revealed that adopting this mindset requires moving away from a centralized control approach and adopting a community-based collaboration model. However, the competitive and centralized nature of current ways of doing business makes it difficult to adopt this new mindset.

Finally, when the prominent factors for *private sector professionals* are evaluated, a distribution consistent with the cumulative ranking is observed. This is due to the numerical weight of private sector representatives among the experts participating in the study. For private sector professionals, organizational factors and government variables were considered the most critical.

"Top Management Support" ranked first, "Managerial Level Technology Affinity" ranked second, followed by "Regulatory Environment Uncertainty," "Competitive Pressure" and "Technology Readiness". These variables are discussed in detail within the overall findings and reflect the focus of private sector professionals on organizational readiness, regulatory uncertainties and technological adaptive capacity.

These results clearly demonstrate the importance that private sector professionals attach to organizational leadership, regulatory compliance and competitive pressure in the technology adoption process.

4.3.2. Evaluation within the Framework of Existing Literature

The findings of this study are in general agreement with the existing literature on blockchain technology adoption and confirm the key factors emphasized in the literature.

In particular, top management support (Clohessy & Acton, 2019; Gökalp et al., 2022), technological complexity (Rejeb et al., 2022; Kouhizadeh et al., 2021), regulatory support and legal uncertainties (Saber et al., 2019; Rejeb et al., 2022), perceived benefit (Queiroz et al., 2020), privacy and security concerns (Kumar Bhardwaj et al., 2021; Mthimkulu and Jokonya, (2022), technology immaturity (Rejeb et al., 2022; Kouhizadeh et al., 2021), and technological compatibility (Agi & Jha, 2022). The findings of this study provide a framework in line with the literature by detailing how these factors shape the blockchain adoption process. In addition, this study contributes to the literature with findings specific to Türkiye.

In line with the literature, the immaturity of the technology reveals the limitations and early-stage nature of blockchain in commercial applications, which is similarly emphasized in the literature (Rejeb et al., 2022; Kouhizadeh et al., 2021). Scalability stands out as a key technical challenge, with concerns over the capacity to manage data volume growth and computing complexity, which is in line with findings in the literature (Choi et al., 2020; Vafadarnikjoo et al., 2023). Similarly, privacy and security concerns highlight concerns about data security risks and potential attacks, confirming the importance of these factors in the blockchain adoption process (Kumar Bhardwaj et al., 2021; Mthimkulu and Jokonya, 2022).

Top management support and organizational readiness are critical factors for the success of blockchain projects, as noted in the literature (Clohessy & Acton, 2019; Shahzad et al., 2024). Among environmental factors, regulatory environment uncertainty (Saber et al., 2019; Rejeb et al., 2022) and competitive pressure (Tasnim et al., 2023; Gökalp et al., 2022) have emerged as important external motivators for blockchain adoption. Moreover, in terms of individual factors, perceived benefits and trust in the technology (Queiroz et al., 2020; Lin et al., 2023) were among the key factors shaping individuals' positive attitudes towards the technology.

Moreover, this study highlights some issues that have been less discussed or ignored in the literature with contributions specific to the Turkish context. For example, how regulatory uncertainty in Türkiye undermines trust in technology and how cultural dynamics make it difficult to adopt decentralized structures are among the unique perspectives this study offers to the literature. While public support and legal uncertainties are frequently addressed in the literature, bureaucratic barriers have not been

examined in detail. This study fills this gap by detailing bureaucratic challenges specific to Türkiye, such as the complexity of public procurement processes, budget constraints, lack of public-private sector cooperation, and fear of legal sanctions.

In terms of individual factors, this study has drawn attention to factors that negatively affect the perception of technological benefits. In particular, it analyzed how the lack of practical examples and simulation tools, prejudices and uncertainties towards the technology, negative media influence and speculative news shape the perception of the technology.

In the Turkish context, the media's *misperception* of blockchain technology, often *equating it with cryptocurrencies*, has been identified as a significant barrier in this study. *Speculative media coverage* increases prejudices against the technology and makes adoption difficult. This study emphasizes that accurate information and awareness campaigns play a critical role in addressing such misconceptions.

Another unique finding is the impact of brain drain in Türkiye on technology adoption. The outflow of qualified experts abroad has been identified as a major factor limiting the viability and sustainability of blockchain projects. This is a common challenge in developing countries and emphasizes the need for incentive policies to retain talented human resources.

Furthermore, the blockchain mindset is highlighted as a significant finding that underscores the importance of transitioning from a centralized control approach to a community-based collaboration model. This study indicates that organizational structures and cultural dynamics in Türkiye may face challenges in adapting to this paradigm shift. Structures influenced by centralized management approaches may experience resistance to the transparency and collective processes introduced by blockchain. In this context, it is suggested that organizational transformation programs and cultural adaptation initiatives aligned with blockchain principles could facilitate this transition.

Moreover, *the resistance* in Türkiye's centralized governance structures *to the decentralized structure of blockchain* is identified as an important barrier in this study. The concern that decentralized structures may lead to a loss of control at the administrative levels stands out as a factor limiting blockchain adoption.

Finally , the lack of pilot projects and feedback mechanisms in Türkiye makes it difficult to assess the real-world benefits of blockchain technology. This lack increases skepticism among users and slows down adoption processes.

In conclusion, this study both supports the general trends in blockchain technology adoption by presenting findings that are in line with the existing literature and makes a unique contribution to the literature by examining in-depth the less discussed dynamics in the Turkish context. In this context, the findings of the study provide a guiding framework for theoretical and practical approaches at both global and local levels.



CONCLUSION AND RECOMMENDATIONS

This study combines and analyzes both quantitative and qualitative findings on the adoption of blockchain technology and allows for a detailed examination of the critical factors that emerge in different dimensions. The results of the study provide a holistic approach to the effects of organizational, individual, technological and environmental factors, as well as contextual and perceptual dynamics on blockchain adoption. The findings are in line with the existing literature and provide new insights specific to the Turkish context, emphasizing the importance of interdisciplinary approaches.

The findings for the first research question, ***RQ1: "What are the critical factors affecting the adoption process of blockchain technology and how can these factors be categorized based on TAM, UTAUT, TOE and DOI frameworks?"*** were obtained through the Systematic Literature Review method. Through this method, 50 critical factors related to the adoption of blockchain technology were identified and these factors were classified under five main categories: technological, organizational, environmental, innovation-specific and individual factors. Under technological factors, scalability, compatibility, security and cost were identified as the main issues, while the complexity and inadequacy of the technological infrastructure were identified as the main problems. In organizational factors, top management support and organizational readiness stood out as the most critical elements; leaders' openness to innovation and their capacity to adapt to digital transformation were decisive in this process. Among environmental factors, regulatory uncertainties, lack of public-private collaboration and economic factors were identified as significant barriers. As for innovation-specific factors, the perceived usefulness, complexity and controllability of the technology were among the factors affecting adoption processes. In terms of individual factors, trust in the technology, perceived benefits, and individuals' attitudes towards the technology stood out in terms of their impact on adoption. These classifications enabled a multidimensional analysis of the adoption process of blockchain technology and strengthened the accumulation of literature based on TAM, UTAUT, TOE and DOI theoretical frameworks.

The ranking analysis of the second question of the research, ***RQ2: "Which factors are prioritized in the adoption process of blockchain technology and do the importance levels of these factors vary according to different expert profiles?"*** shows that organizational factors play a fundamental role in the adoption of blockchain technology.

Top management support, organizational readiness and technological proximity at the managerial level were the most important factors that facilitated the process in all expert profiles. This highlights the strategic importance of leadership and organizational infrastructure in technological integration.

Overall, organizational factors were rated as the most critical across all expert groups. Top management support, organizational readiness and technological proximity at the managerial level were prioritized across all expert groups. These findings highlight that organizational leadership and effective management of resources play a strategic role in blockchain adoption processes.

However, prioritization among different groups of experts varies according to sectoral and professional perspectives. Public sector experts rated security risk and privacy concerns among the most important factors. These factors point to the importance of the regulatory framework and security standards in technology applications for the public sector. Moreover, public sector representatives are more sensitive to regulatory environment uncertainties, suggesting the need for a clearer and harmonized regulatory framework.

For private sector experts, organizational factors, as well as external and financial factors such as trading partner pressure, competitive pressure and cost, were found to be of higher priority. The views of private sector representatives confirmed that competition and trade relationships in particular shape blockchain adoption decisions. These findings suggest that blockchain adoption decisions in the private sector are more focused on functionality and cost-efficiency.

While academics rated organizational readiness as the most important factor, they also drew attention to innovation-specific factors. The compatibility of the technology and the transparency-enabling features of blockchain were rated as highly important by this group. This perspective suggests that the long-term impacts of technology should be analyzed and innovations should be considered in broader contexts.

In conclusion, these findings suggest that the needs of all stakeholders need to be taken into account when developing effective strategies for the adoption of blockchain technology.

The third research question consists of three sub-questions. These sub-questions focus on identifying the contextual and perceptual dynamics related to the adoption of blockchain technology in Türkiye's SCM (RQ3a), identifying new factors affecting this process (RQ3b) and developing actionable strategies based on expert perspectives to overcome these barriers (RQ3c). The findings for these questions were revealed through qualitative analysis of semi-structured interviews.

The findings of the qualitative analysis of **RQ3a: "What are the contextual and perceptual dynamics underlying the adoption of blockchain technology in Türkiye's SCM?"** revealed that the contextual and **perceptual** dynamics related to the adoption of blockchain technology in Türkiye's SCM can be examined under seven main categories. These categories are cognitive and behavioral barriers, barriers due to perceived risk and uncertainty, technological barriers, organizational barriers, external environmental barriers, regulatory and political barriers, and supply chain-specific barriers. These categories provide the opportunity to evaluate the effects of contextual dynamics on the blockchain adoption process in a multidimensional framework.

Firstly, within the context of cognitive and behavioral barriers, issues such as lack of knowledge and awareness about blockchain, its association with cryptocurrencies, high-profile bankruptcies, and media-driven prejudices have been identified as key challenges. Additionally, investing in blockchain without a clear understanding of its necessity and concerns regarding its security have emerged as critical barriers. Furthermore, the adherence to centralized management structures, conceptualized in this thesis as the "blockchain mindset", comprising elements such as "*Decentralization Readiness*", "*Open Collaboration*" and "*Community-Driven Approach*", has been identified as a notable perceptual challenge. The findings suggest that the limited awareness and abstract nature of blockchain technology in society and institutions contribute to misperceptions and trust issues, thereby hindering its adoption.

In the context of perceived risks and uncertainties regarding blockchain adoption, it has been revealed that the fact that blockchain is an immature technology, uncertainty of technological benefits, limited practical examples; perceived risks related to security, privacy and reliability, and environmental concerns are important barriers.

In terms of technological barriers, barriers related to the perceived and structural complexity of blockchain, cost concerns, scalability issues, and compatibility of the

technology with other existing technologies were identified. In this context, perceived complexity was found to be caused by confusion in technology selection, ambiguity at the level of abstraction and lack of clear role models. Structural complexity was found to be caused by the multi-layered nature of the blockchain and the difficulties in selecting the appropriate proof mechanism. Furthermore, in the context of scalability issues, it was emphasized that 'increasing transaction volume', 'uncertainty in the number of users in the system' and 'the intensity of verification processes' are limiting factors in terms of scalability.

In the context of organizational barriers, the most important factors identified by private sector professionals in the quantitative analysis were top management support and technological proximity at the managerial level; lack of digital transformation and technical expertise; resistance to digital transformation in business processes; size and existing IT infrastructure due to organizational characteristics; and barriers under the headings of Traditional Hierarchy, Attitudes, and Organizational Culture. In this context, among the reasons for digital transformation and lack of technical expertise, it was stated that blockchain projects should be handled with a multidisciplinary approach, not only by technical personnel, and that different competencies such as financial literacy are needed in addition to technical expertise. In addition, factors such as private sector working conditions and brain drain underline this shortage. In addition, traditional hierarchical structure, cultural resistance to technological change and conservative attitudes have been identified as important barriers to blockchain adoption in Türkiye. The dominant centralized management approach in organizations, managers' unwillingness to lose control authority, the inability to transition from hierarchical structures to flexible flat structures, the difficulty of persuading managers who adhere to traditional management, and low risk appetite for innovations are among the important findings. In addition, the tendency towards ready-made package programs used in organizations and the inability to give up existing habits also stand out as factors that resist change. In addition, low digitalization capacity due to inadequacies in IT infrastructure, difficulties encountered by those using regional systems in integrating with global systems, technical difficulties in data transfer, lack of blockchain awareness among SMEs, and differences in digitalization focus are among the obstacles. Finally, the fact that large companies that have made larger technology investments do not prefer to abandon their existing systems and make a new investment has been identified as another noteworthy barrier.

External Environmental Barriers are discussed in the context of micro-environmental and macro-environmental barriers. At the micro level, unnecessary investment in blockchain due to external pressures, network participation and sustainability challenges in the multi-stakeholder structure of blockchain, as well as difficulties in finding a trusted third party were highlighted. In addition, sensationalist effects due to media hype and the fragmented nature of the supply chain sector are among the barriers related to the micro-environment.

At the macro level, differences in countries' socio-cultural and regulatory environments, differences in development levels, economic fluctuations, recession expectations and cost-cutting efforts due to inflation were found to be external factors hindering blockchain adoption.

In the context of regulatory uncertainties and bureaucratic barriers, many barriers arising from legal uncertainties and bureaucratic procedures have been identified. In particular, the elements that define bureaucratic barriers include the perception of blockchain as unnecessary in the public sector, difficulties in public-private sector cooperation, problems arising from lack of regulatory understanding, budget caution and fear of legal sanctions. The current level of trust between public institutions, doubts about the necessity of blockchain and the perception of low added value in the public sector cause this technology to be considered unnecessary.

In addition, the inadequacy of cooperation mechanisms with the private sector and existing tender processes were found to be insufficient to meet new technology demands. Concerns about loss of control by the public sector, the usability of blockchain in informal economies and privacy concerns were also among the major bureaucratic obstacles. Fear of legal sanctions in connection with privacy and budgetary reservations in the public sector limit investments in new technologies such as blockchain. In addition, overly restrictive regulations, lack of standardization and gray areas due to lack of regulation, i.e. the uncertainty of the legal framework, create regulatory uncertainty in public institutions. Inadequate legislation and lack of regulatory support in sectoral applications have also been identified as other factors limiting blockchain adoption. In addition, the lack of technical expertise and passive attitude in the public sector was also highlighted as a major inhibiting factor.

Finally, barriers in the supply chain context are examined under the headings of Control Resistance in Supply Chain, Supply Chain Power Imbalance and Supply Chain

Integration. The incompatibility of management habits with the transparency and control-sharing mechanisms offered by blockchain; the power imbalance reducing the demand for the equity and transparency provided by blockchain; and the difficulties in harmoniously integrating all components in the supply chain are the main factors limiting the effective implementation of blockchain technology. Overcoming these barriers requires the development of holistic strategies that take into account not only supply chain-specific dynamics, but also the needs of the wider ecosystem. In addition, establishing collaboration mechanisms to engage all stakeholders is an integral part of this process. According to the findings of the qualitative analysis, all other barriers have an indirect impact on the supply chain, while the barriers addressed in this category are reported as supply chain specific.

In line with another research question ***RQ3b: "What new factors influencing adoption can be identified through qualitative insights?"***, ***new contextual factors specific to Türkiye were identified.*** In particular, regulatory uncertainties, media influence, cultural dynamics, centralized governance structures and brain drain stand out as unique factors limiting technology adoption in the Turkish context.

Regulatory uncertainties, the lack of a legal framework in Türkiye, and gray areas cause trust issues in the adoption of blockchain technology at both individual and organizational levels. This, combined with the complexity of bureaucratic processes, the lack of public-private partnership mechanisms, and the fear of legal sanctions, limit investments in blockchain projects, especially in public institutions. In addition, the rigidity of public procurement processes and budget constraints further complicate the viability of the technology.

Media influence plays a critical role in the misperception of blockchain in the Turkish context. The media's approach, which often equates blockchain technology with cryptocurrency, increases prejudices against the technology and complicates adoption processes. Speculative media content reinforces mistrust of the technology among individuals and organizations, while the lack of awareness-raising and accurate information campaigns makes it difficult to correct this misperception. The findings suggest that blockchain technology is not merely a technical innovation but also necessitates a cultural transformation. By incorporating the concept of "Blockchain Mindset" into the discussion, the study highlights a paradigm shift that involves

transitioning from centralized management to more transparent and collaborative processes. However, the study also indicates that centralized organizational structures and cultural dynamics in Türkiye may present significant challenges in adapting to this shift. Such resistance could make it challenging for organizations to fully embrace the transparency and collective control mechanisms that blockchain technology offers.

Brain drain has been identified as another unique factor limiting the viability of blockchain projects in Türkiye. The outflow of talented human resources abroad reveals the lack of competencies such as technical expertise and financial literacy, especially in blockchain projects that require multidisciplinary knowledge. This situation negatively affects the sustainability and effectiveness of projects.

Finally, the *lack of pilot projects and feedback mechanisms* required to test the viability of blockchain in Türkiye makes it difficult to assess the tangible benefits of the technology. This lack creates skepticism among users and slows down adoption processes.

These new factors identified in the Turkish context reveal that blockchain technology requires not only technical but also social, cultural and institutional transformation. These findings emphasize the need to adapt existing adoption theories to local contexts and provide important contributions to the literature.

Within the scope of the research question ***RQ3c: "What actionable strategies based on expert perspectives can be proposed to address these barriers and accelerate blockchain adoption in Türkiye"***, various strategies were developed based on the findings of the qualitative analysis.

These strategies aim to overcome the factors that hinder the adoption of blockchain technology in Türkiye and facilitate the widespread adoption of the technology. The findings of the qualitative analysis suggest multifaceted solutions at individual, organizational and regulatory levels. The strategies range from raising awareness to clarifying the regulatory framework.

In line with participants' views, incentive and education strategies were identified as an important starting point. It was suggested that the government should provide financial incentives to businesses, support R&D expenditures and develop the entrepreneurship ecosystem. In addition, it was emphasized that education programs should be updated and

areas of expertise related to blockchain technology should be expanded. In order to prevent brain drain and protect qualified human resources, working conditions should be improved and more flexible regulations should be implemented, especially in technoparks. Increasing the support given to start-ups was stated as a critical element to ensure the sustainability of the blockchain ecosystem.

Information and perception management strategies are another prominent area to prevent misperception of blockchain technology and raise public awareness. Participants emphasized the need to correct the negative perception created by the media with speculative news and the importance of informing the public correctly. It was stated that making local applications, such as popular systems such as Istanbul Kart, blockchain-based could contribute to the adoption of the technology by large masses. It was also suggested that events and training programs should be organized to raise awareness in companies and public institutions.

Under innovative approaches and project development strategies, it is proposed to increase collaboration with external innovative initiatives, organize digital transformation competitions and develop flexible smart contracting systems. These strategies will enable both public and private sector projects to be realized more quickly and efficiently. Virtual business models in particular stood out as an effective solution for projects that require flexibility and speed.

Pilot projects, testbeds and trial-and-error strategies are effective ways to test the applicability of technology in the real world. Small-scale projects and sandboxing accelerate learning and adaptation processes for both entrepreneurs and public institutions. Trial-and-error processes offer valuable learning opportunities in the development of technological innovations.

Regulatory and legislative strategies focused on eliminating regulatory uncertainties that limit the adoption of blockchain technology in Türkiye. Participants stated that regulations should be clear, transparent and incentivize innovation. It was emphasized that public institutions should clarify the regulatory framework by developing sectoral standards and guidelines. Laws should not only be restrictive but also incentivize innovative projects.

The role of the state stands out as a critical element in the adoption of blockchain technology. Public-private sector cooperation was identified as a process that should be

led by the government. Participants stated that public institutions should collaborate more with the private sector to better adapt to the technology. The government's establishment of a regulatory framework that encourages innovation and covers all stakeholders will accelerate the adaptation process.

Finally, gradual transition and harmonization strategies have been proposed to increase the applicability of blockchain technology. The establishment of standards, the implementation of incentive-based transition methods and the adoption of mandatory transition strategies in certain areas will contribute to accelerating the adoption process. These strategies provide a holistic framework to support the adoption of blockchain technology in the Turkish context.

These strategies provide a holistic framework to support the adoption of blockchain technology in the Turkish context. Ranging from incentives to regulations, innovative project development to knowledge management, these approaches aim to overcome existing barriers as well as accelerate the proliferation of the technology. In Türkiye, government leadership, public-private partnerships, and public awareness-raising processes are key to the adoption of this technology.

Recommendations Aligned with Identified Barriers

The findings from this study reveal that there is a strong correlation between the barriers to blockchain adoption, particularly in the Turkish context, and the strategies to overcome these barriers. In order to provide a clear and actionable roadmap to overcome these challenges, a comprehensive framework has been developed that matches the identified barriers with appropriate strategies. By synthesizing the findings of the qualitative analysis, the framework highlights the importance of context-specific approaches and systematically presents strategic recommendations to accelerate the adoption of blockchain technology.

The Table 26 below provides a holistic understanding by placing the appropriate solution against each barrier.

Table 26*Recommendations Aligned with Identified Barriers*

<i>Barrier Type</i>	<i>Barrier Subcategory</i>	<i>Specific Challenges Identified</i>	<i>Recommended Strategies</i>
<i>Technological Barriers</i>	Lack of Knowledge and Awareness	General distrust in new technologies	Education and awareness campaigns
	Cost Concerns	High implementation costs	Financial incentives and tax reliefs
	Scalability Issues	Architectural complexity in implementation	Pilot projects and sandbox applications
<i>Cognitive and Attitudinal Barriers</i>	Prejudice and Negative Perception	Perception rooted in cryptocurrency concerns	Media education and awareness programs
	Lack of Communication	Limited dissemination of blockchain benefits	Corporate training and public engagement
<i>Perceived Risks and Uncertainties</i>	Security and Privacy Concerns	Data reliability and security challenges	Compliance frameworks and regulatory guidelines
	Environmental Concerns	Negative environmental impact perception	Sustainable blockchain solutions
<i>Organizational Barriers</i>	Lack of Digital Expertise	Insufficient workforce with blockchain skills	R&D incentives and workforce upskilling programs
	Resistance to Change	Traditional hierarchical organizational culture	Change management initiatives
<i>Regulatory and Policy Barriers</i>	Legal Uncertainties	Lack of standardization in regulations	Transparent and supportive regulatory framework
	Bureaucratic Challenges	Delayed approvals and high compliance costs	Streamlined approval processes and regulatory sandboxes
<i>Supply Chain Specific Barriers</i>	Integration Issues	Resistance to data sharing among partners	Standardized blockchain integration frameworks
	Power Imbalance	Dominance of larger players	Collaborative governance models

Source: Created by Author.

Contribution

This thesis has made significant theoretical, methodological and practical contributions to the literature on the adoption of blockchain technology and has enabled the extension and context-specific adaptation of existing theories.

*The **Theoretical Contributions** can be summarized as follows:*

i. Extension and Integration of Existing Theories of Adoption: This study contributed to, validated and integrated existing theories such as the TOE Framework, TAM, Diffusion of Innovations Theory (DOI) and Unified Theory of Technology Acceptance and Use (UTAUT). The study extends the scope of these theories by considering technological, organizational, environmental and individual factors in a holistic framework. Furthermore, variables specific to the Turkish context such as regulatory uncertainty, cultural dynamics and media influence were integrated into the theories. This expansion has increased the adaptability of universal theories to meet context-specific needs and brought a new perspective to theoretical discussions.

ii. The Role of Context-Specific Variables and External Factors: The study identifies unique variables such as regulatory uncertainties, media influence, decentralized governance structures, and cultural resistance in the Turkish context and details their impact on the adoption of blockchain technology. Moreover, the decisive role of exogenous factors such as regulatory support and uncertainties, third-party trust issues, competitive pressures and demands from trading partners in the adoption process is highlighted. These findings suggest that adoption theories need to be adapted to local contexts and multi-stakeholder ecosystems.

iii. Discussion of the Concept of “Blockchain Mindset”:

This study has contributed to the understanding of the “Blockchain Mindset” concept, which encompasses decentralization, transparency, and collaborative cultural transformation. It emphasizes the role of organizational and cultural adaptation in the adoption of blockchain technology. This perspective provides further insights into the relationship between organizational culture and technology adoption.

iv. Specific Contributions to Emerging Economies: In the Turkish context, the effects of regulatory deficiencies, brain drain, resource shortages and infrastructure problems on the

adoption of blockchain technology are discussed. These findings emphasize the need to reevaluate universal theories to meet the specific needs of developing economies.

Methodological Contributions

This research makes significant methodological contributions through the use of a mixed methodology integrating quantitative and qualitative approaches. The combination of the Relative Importance Index (RII) for systematic ranking analysis and qualitative interview analysis allowed for a multidimensional understanding of blockchain adoption. Detailed qualitative analysis using MAXQDA software enabled systematic categorization of categories and subcategories, thereby increasing the contextual depth of the findings.

This mixed-methods design of the study made the findings more reliable and applicable, and provided a replicable framework to the technology adoption literature. Analyzing elements specific to the Turkish context enhances the contextual validity of the findings and provides a valuable precedent for the study of technology adoption in emerging economies. The combination of statistical prioritization and contextual depth strengthened methodological rigor and supported the alignment of the findings between theoretical frameworks and practical applications.

These methodological contributions not only increase the reliability and scope of the research, but also bring an innovative approach to the technology adoption literature.

Practical Contributions

By addressing the regulatory, cultural and economic challenges specific to the Turkish context, this research provides strategic recommendations for the adoption of blockchain technology. The recommendations can be summarized as follows:

- i. Education and Awareness Programs: Targeted awareness campaigns and training programs are vital to address the lack of knowledge and mistrust of blockchain technology. These initiatives should aim to make blockchain technology more understandable, correct misperceptions and highlight successful use cases in different sectors. Adding blockchain-focused courses to university curricula and encouraging vocational training programs can increase the level of technical expertise.
- ii. Regulatory and Policy Reforms: Regulatory uncertainty in Türkiye stands out as a significant barrier to blockchain adoption. Transparent and innovation-friendly regulatory frameworks are necessary to increase stakeholder confidence and incentivize

investments. These public-private partnerships can reduce bureaucratic barriers by supporting pilot projects.

iii. Pilot Projects and Feedback Mechanisms: Small-scale pilot projects can demonstrate the practical benefits of blockchain technology. The creation of regulatory sandboxes can enable controlled testing of blockchain applications, enabling compliance and risk management. Feedback mechanisms should be integrated to optimize and improve projects.

iv. Digital Transformation Incentives: Financial incentives such as grants, subsidies and tax breaks can help organizations overcome initial adoption costs. Encouraging R&D investments and facilitating SMEs' access to finance through blockchain initiatives can accelerate technological integration. Moreover, improving working conditions in tech hubs can mitigate the negative effects of brain drain.

v. Cultural Transformation: A shift from centralized management to a collaborative approach is necessary to align organizational cultures with blockchain principles. Resistance stemming from hierarchical structures and conservative mindsets can be overcome through cultural transformation programs. Emphasizing transparency, openness and collaboration can contribute to creating a blockchain-friendly environment.

vi. Technological Solutions and Innovation: Focused R&D efforts are important to overcome technological barriers such as scalability, integration difficulties and high costs. User-friendly and scalable blockchain solutions should be developed in cooperation with technology providers. In addition, protocol standardization and promoting cross-system compatibility can facilitate the adoption process.

vii. Media and Perception Management: The media plays an important role in shaping public perception of blockchain technology. Public campaigns should aim to correct misperceptions and emphasize the benefits of blockchain beyond cryptocurrency. Highlighting successful applications in areas such as public services can contribute to building credibility and reputation.

viii. Government Leadership and Public-Private Partnership: Government should play a central role with progressive policies that balance innovation and stability. The adoption of blockchain by public institutions can serve as an example to demonstrate the

effectiveness of the technology. Strengthening collaboration with the private sector can lead to more effective use of resources and expertise.

Figure 50, below summarizes the strategic pathways proposed in the research.

Figure 50

Strategic Pathways to Blockchain Adoption



Source: Created by Author

This visualization provides a comprehensive overview of strategic pathways for blockchain adoption, visualizing how the proposed approaches address regulatory, cultural, technological and economic elements. Each strategic pathway is geared towards overcoming the key barriers identified in the study and supporting the implementation processes.

Research Limitations and Directions for Future Research

The limitations of this study and recommendations for future research go beyond the existing findings on the adoption of blockchain technology and contribute to new areas of research. The limitations of the study are related to the sample size, regional focus, methodological approaches, time and resource constraints, and the scope of the factors examined. The research was conducted with a limited number of participants specialized in blockchain technology and SCM. This may limit the direct generalizability of the findings to other sectors or areas of expertise. For example, a detailed examination of the

differences in blockchain adoption processes between small and medium-sized enterprises and large-sized enterprises would be possible with a larger sample.

In addition, the fact that the experts participating in the study were not evenly distributed across sectors (academia, public and private sector) is considered as a potential limitation that may cause the results to be weighted in favor of a particular sector. However, this diversity added significant value to the study; perspectives from different sectors contributed to a more comprehensive understanding of the blockchain adoption process.

The study's focus on the Turkish context means that the results cannot be directly generalized to other countries or regions. Türkiye's economic, regulatory and cultural dynamics may lead to limited interpretation of the findings in an international context. However, similar results may be observed in countries with similar socio-cultural, political or economic characteristics to Türkiye. The validity of this assumption should be tested in future comparative studies to provide a broader framework for the adoption of blockchain technology.

Methodologically, the study provides a comprehensive analysis using a combination of both quantitative and qualitative methods. While this approach provides contextual depth, it may pose challenges to the generalizability of some findings. Participants' subjective assessments may limit the accuracy and precision of the findings. Moreover, the fact that the study was conducted over a specific time period may not fully reflect the rapidly changing nature of blockchain technology. The rapid development of technological innovations carries the risk that the results of the study may become outdated over time. The study addresses important issues such as energy consumption, sustainability and social impacts in a more limited way.

Future research should overcome these limitations and focus on developing a more comprehensive understanding of the adoption of blockchain technology. Data from a larger and more diverse sample across different sectors and geographical regions will contribute to a better understanding of differences across sectors. Comparative studies can offer a deeper insight into the universal and contextual aspects of the technology by examining how blockchain adoption processes vary across different countries and cultural contexts. Longitudinal studies, in particular, are seen as an important tool to assess the long-term impact of blockchain technology and changes in adoption processes.

Moreover, the unique variables proposed in this study can be more comprehensively addressed by testing them in theoretical models in future research. Large-scale quantitative studies can contribute to the statistical validation of blockchain adoption factors, supported by qualitative findings. Research focusing on pilot applications can accelerate the adoption process by demonstrating the tangible benefits of blockchain technology. Studies on energy consumption and sustainability can help develop more sustainable solutions by evaluating the environmental impact of technology. Research examining the impact of the media on the perception of technology can provide strategic recommendations for eliminating misperceptions and raising awareness.

Another important suggestion for future studies is that the choice of theories for academics who want to focus on technology acceptance in the blockchain field should differ depending on the dimensions they address. Studies focusing on individual and perceptual factors may benefit from the TAM and the UTAUT. On the other hand, studies focusing on the technology itself and its innovation characteristics may offer a more appropriate approach based on the DOI.

Considering the multidimensional factor structure in the acceptance of blockchain technology, it is recommended to consider the relational context between theories and use more inclusive models. In this direction, integrated approaches that consider individual, organizational and environmental factors together in technology adoption processes will contribute to the evaluation of blockchain adoption in a broader perspective. For example, while government incentives or sectoral regulations play an important role in the adoption process of blockchain technology by organizations, they also directly affect individuals' perceived benefits and intention to use the technology.

Finally, future studies could compare blockchain adoption factors with other technology adoption studies in the Information Systems (IS) literature to identify similarities and differences. In this way, it can be determined how blockchain differs in adoption processes compared to traditional information systems and other technologies and which factors are unique to blockchain. Such a comparison can provide a better understanding of the dynamics shaping the adoption of blockchain at the organizational and individual level, which can provide guidance for determining the evolution of blockchain and its potential future use cases.

In conclusion, the limitations of this study suggest that while significant progress has been made towards the adoption of blockchain technology, there is still room for expansion. Future research that addresses these limitations can provide more robust theoretical and practical contributions towards broader evaluation and adoption of the technology. In this context, comprehensive studies addressing the multidimensional nature of blockchain technology would be an important contribution to both academic and applied literature.



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APPENDIX

Appendix 1. Expert Opinion Survey Form

Expert Opinion Form on Identifying the Factors Influencing Blockchain Adoption in Supply Chain Management in Türkiye

Dear Expert,

This study is part of a PhD thesis study conducted to identify the factors affecting the adoption of Blockchain technology in Supply Chain in the context of Türkiye, prioritize these factors and propose a new theoretical framework.

This study seeks to answer the questions: "Which factors are important for the adoption of Blockchain technology in supply chains in Türkiye?"; "Which factors should be prioritized in the adoption process of Blockchain technology in the supply chain context in Türkiye?".

All responses obtained within the scope of the research will be used for purely scientific purposes and your personal information will be kept confidential. Thank you very much for your participation and support in the study.

Please evaluate each variable below under five different categories as "*Technological Factors*", "*Institutional Factors*", "*Environmental Factors*", "*Individual Factors*" and "*Innovation Specific Variables*" with their explanations in the context of Türkiye and score them using a scale of **1 (Not Important at All)** to **10 (Very Important)** according to their importance in the blockchain adoption process.

Detailed information about the thesis is provided in the subsequent section.

Research Assistant. Gör. Seren ÖZSOY

Prof. Dr. Aykut Hamit TURAN

Introduction to the Dissertation

Blockchain technology today attracts the attention of both the business world, academia and the public sector with its unique features and technology solutions. Although its potential effects have not yet been sufficiently explored, industrial investments in this field are increasing, public policies are being developed, and academic studies are accelerating. Despite the increasing interest in blockchain technology, adoption rates in

countries are still quite low. The argument that the increase in the adoption rate of blockchain technology depends on identifying the barriers and incentives to adoption and developing strategies accordingly is the starting point of this thesis.

Various studies in the literature have investigated the influential factors for blockchain adoption and revealed different results for countries with different levels of development and sectors with different characteristics. The results of the current research show that a universal blockchain adoption model is not possible when country-specific factors are taken into account. Therefore, identifying the factors affecting the adoption of blockchain technology in Türkiye and presenting a theoretical model is important both in terms of contributing to the academic literature and supporting public and industry initiatives to increase the awareness of blockchain.

The potential of blockchain technology to transform supply chain management and make it more sustainable with the technology solutions it offers is the motivation for this thesis to focus on the adoption of blockchain technology in the supply chain domain. In fact, blockchain technology is an important technological tool for reducing costs, mitigating risks and increasing efficiency in supply chain management thanks to its prominent features such as distributed network structure, immutability, auditability, traceability and smart execution. With blockchain technology, the traceability and tracking of shipments increases, which brings transparency. Other advantages include the ease of access to data by storing data in a single unit and the ability to carry out transactions through a secure system based on network authentication without the need for a third party.

In this context, the aim of this thesis is to "identify the factors affecting the adoption of Blockchain technology in Supply Chain in the context of Türkiye, prioritize these factors and propose a new theoretical framework". In line with this purpose, we need the opinions of experts in the field on which of the variables obtained from the Supply Chain and blockchain technology adoption literature are important criteria for Türkiye. Your responses are extremely important as this section will form the basis of the theoretical model to be established and tested for Türkiye.

Thank you very much for your support and contributions.

** Specifies the mandatory question*

Technological Factors

The factors in this group relate to the external and internal technologies and characteristics that will influence a firm's adoption of Blockchain technology in Supply Chain Management.

Please evaluate each factor below in the context of Türkiye and rate it according to its importance in the blockchain adoption process using a scale of 1 (Not at all important) to 10 (Very important).

1. Technological Volatility *

Technological Volatility is defined as the rate of change in the technical characteristics of blockchain technology. The perception of uncertainty regarding the changeability of the technology may reduce firms' willingness to invest and a barrier to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

2. Technological Immaturity *

Technological Immaturity is related to the fact that blockchain technology is a relatively new technology with few commercial applications. High uncertainty about the development of immature technologies and their compatibility with existing systems can be a barrier to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

3. Existing Information Technology Infrastructure *

The difficulty of replacing and/or adapting existing legacy systems can create barriers to the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

4. Scalability *

Scalability relates to the ability of blockchain technology to cope with increasing volumes of data. Potential communication breakdowns and latency concerns due to the increasing number of transactions on the blockchain can create barriers to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

5. Technology features: trial and reversibility*

The difficulty of technology trialability and reversibility can be a barrier to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

6. High Energy Consumption of Technology*

The high energy costs associated with blockchain technology can be a barrier to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

7. Technology Implementation Cost*

The high implementation costs of blockchain technology and the uncertainty of return on investment may negatively affect its adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

8. Privacy Concerns*

Privacy concerns and the perceived risk of disclosing personal information in blockchain networks and transactions can create barriers to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

9. Security Risk*

Concerns about the security of blockchain networks, the perception that blockchain networks are more vulnerable to attacks, the risks of cyber-attacks, and the perceived risk of crypto theft can create barriers to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

10. Potential of Usage in Informal Economies *

It refers to the use of blockchain technology as a means of payment in money laundering activities such as gambling, terrorism, unregistered trade, which carry a high risk due to the inability to control blockchain transactions. This may negatively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

Organizational Factors

These factors in this group relate to the resources and intrinsic characteristics of the organization that will influence the adoption of Blockchain technology in a firm's supply chain management.

Please evaluate each factor below in the context of Türkiye and rate it according to its importance in the blockchain adoption process using a scale of 1 (Not at all important) to 10 (Very important).

1. Organizational Culture *

Organizational culture refers to the behaviors, beliefs and habits specific to the organization. An organizational culture that encourages employees and managers to take risks for the successful implementation of blockchain technology can positively affect adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

2. Reluctance to Change/Resistance to Change *

It is expressed as unwillingness to adopt new technology and change existing technology. Innovation is related to openness and willingness to take risks. Resistance to change can negatively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

3. Organizational Readiness *

Institutional readiness refers to the Financial, Technological, Human Resource and Knowledge capacity of the organization that affects the implementation and use of the technology. High organizational readiness can positively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

4. Financial Resources *

Adoption and implementation of blockchain technology requires investment in advanced technology. Lack of financial resources can create barriers to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

5. Technological Readiness*

An organization's technology readiness refers to the availability of hardware, software and specialized manpower to enable the adoption of new technology. High technological readiness can positively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

6. Lack of Expertise, Technical and Digital Knowledge*

Inadequate knowledge about the characteristics of blockchain technology and its integration into the supply chain can negatively impact adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

7. Human Resource Adequacy*

The shortage of Human Resources with the competence to use technology and the training costs of Human Resources may be barriers to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

8. Cost Concerns *

High technology installation and maintenance costs, uncertain returns on investment and inadequate financing can be barriers to technology adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

9. Top Management Support *

Top management support refers to providing the necessary support - allocating adequate human, financial and infrastructure resources - for the effective implementation of blockchain technology and the development of blockchain programs. Top management support can encourage blockchain adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

10. Other Technology Priorities *

The firm's prioritization of other technology investments may create barriers to the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

11. Technological Affinity at the Management Level *

Technology affinity refers to an individual's tendency to actively engage with or avoid technology in order to cope with it. Management staff's affinity for blockchain technology may encourage blockchain adoption at the organizational level.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

12. Perceived Data Quality*

Concerns about the accuracy of the data entered into the blockchain may reduce the rate of adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

13. Trust in Technology*

Trust is a subjective belief that the trusted party will fulfill its obligations as expected from the trusting party. Confidence that blockchain has the potential to make a positive

change to existing processes can positively influence technology adoption by making firms more likely to invest in the infrastructure and resources necessary for adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

14. Firm Size *

It reflects the idea that as firm size increases, the firm may be more inclined to adopt new technology than smaller firms as the firm's risk management capability improves. Firm size may positively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

Environmental Factors

Factors in this group refer the influence of external sources that will affect the adoption of Blockchain technology in a firm's supply chain management.

Please evaluate each factor below in the context of Türkiye and rate it according to its importance in the blockchain adoption process using a scale of 1 (Not at all important) to 10 (Very important).

1. Regulatory Environment Uncertainty*

Perceived uncertainty or lack of clarity regarding the legal and regulatory situation regarding the use of blockchain technology can be a barrier to technology adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

2. Regulatory Support*

Regulatory support refers to policies and laws that play an important role in encouraging the adoption of new technology. The existence of policies and laws to encourage the use of blockchain technology can increase adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

3. Standardization Uncertainty *

It can be expressed as the perceived uncertainty regarding the existence and consistency of Blockchain standards within the industry or across sectors. Standardization uncertainty can negatively affect adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

4. Trade Partner Pressure*

A trading partner is a business relationship that may involve two or more organizations or customers. The organization also includes a supplier relationship. Trading partners can promote the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

5. Vendor Support *

Vendor support to the provision of security controls, user training and technical support for the successful implementation of new technology. Vendor support can positively influence users' intention to adopt the new technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

6. Customer Interest*

It is referred to as customer interest in traceability information and other product-related data on the blockchain. Customer interest in blockchain can be an incentive for the organization to adopt blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

7. Industry Pressure*

Industry-wide initiatives to promote the use of blockchain technology could positively impact adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

8. Competitive Pressure*

Competitive pressure refers to the internal pressure and desire to gain a competitive advantage that drives companies to adopt innovative technologies while facing pressure from upstream and downstream actors in the supply chain and pressures from new developments in business models and industry standards. The desire to gain a competitive advantage over competitors can positively influence blockchain adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

9. Market Dynamics *

Market dynamics refers to the ever-changing state of a highly competitive and complex environment. The ever-changing environment may negatively impact the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

10. Information Sharing *

Knowledge sharing among supply chain members or within the industry can encourage the adoption of new technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

11. Lack of Successful Examples *

The lack of successful examples of blockchain technology can be a deterrent to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

12. Sustainability Issues *

Environmental concerns due to the technology's high electricity consumption can be a barrier to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Very
at All											Important

13. Perceived Network Development*

Perceptions that the technology adopted can improve the quality of existing, internal or external networks or create new networks. Belief in network development can be an incentive for technology adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

14. Cultural Differences among Supply Chain Partners *

It refers to the different geographical or organizational cultures of supply chain actors and partners that may hinder the adoption of blockchain technology. Cultural Differences can negatively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

Innovation-Specific Factors

Variables in this group refer factors arising from the structure and characteristics of Blockchain technology.

Please evaluate each factor below in the context of Türkiye and rate it according to its importance in the blockchain adoption process using a scale of 1 (Not at all important) to 10 (Very important).

1. Relative Advantage*

The relative advantage of the technology is the degree to which the benefits it offers are perceived as better than those offered by existing technology. Unlike existing systems, the benefits such as transparency, traceability, reliability, verifiability that the use of blockchain technology will create in the supply chain may encourage adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

2. Complexity *

The complexity of technology is associated with the relative difficulty of understanding and using it. The difficulty of understanding blockchain technology by users may hinder its adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

3. Compatibility *

Compatibility refers to the consistency of the technology with the adopter's existing values and past experiences, as well as the consistency of the corporate culture and existing infrastructure. A high level of compatibility can positively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

4. Maturity *

The relative immaturity of blockchain technology and its lack of commercial application can be a barrier to adoption by increasing the manager's level of risk and uncertainty. Since there is a high level of uncertainty about the development of immature technologies and their compatibility with existing systems, it can be a barrier to adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

5. Blockchain Transparency *

The fact that most transactions through blockchain are transparent, genuine, traceable and verifiable can encourage adoption of the technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

Individual Factors

These are the characteristics that reflect the attitudes, behaviors and perceptions of the individual towards technology acceptance at the individual level.

Please evaluate each factor below in the context of Türkiye and rate it according to its importance in the blockchain adoption process using a scale of 1 (Not at all important) to 10 (Very important).

1. Perceived Benefits of Technology*

While a lack of understanding of blockchain technology and its benefits is a barrier to adoption, perceptions that its use will improve business performance by making tasks more efficient encourage adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

2. Perceived Ease of Use / Effort expectation *

It is defined as "the degree of ease associated with the use of the system". Ease of learning the technology is linked to its simplicity, clarity and understandability. If employees believe that blockchain technology is more difficult to use than the current system, this may negatively affect adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

3. Trust in Technology*

Trust is a subjective belief that the trusted party will fulfill its obligations as expected from the trusting party. The belief that blockchain technology can solve and facilitate business can positively influence its adoption.

Check only one option

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

4. Facilitating Conditions *

It is defined as the degree to which an individual believes that an organization and its technical infrastructure exist to support the use of the system. Individuals' belief in enabling conditions can positively influence adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

5. Affinity for Technology*

Technology affinity to an individual's tendency to actively engage with or avoid technology in order to cope with it. Individuals' affinity for blockchain technology may encourage blockchain adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

6. Social Impact*

It is defined as "the degree to which an individual perceives that significant others believe that they should use the new system". Blockchain can be an incentive for adoption.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

7. Innovativeness *

Innovativeness refers to the user's tendency to be a pioneer in the field of technology. High innovativeness of individuals may positively affect the adoption of blockchain technology.

Check only one option.

	1	2	3	4	5	6	7	8	9	10	
Not											Very
Important	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Important
at All											

Expert Information

1. Which of the following classes of participants do you belong to? *

Check only one option.

- ☐ **Policy Makers & Executives (Public Institutions and Organizations)**
Go to question 62
- ☐ **Academics**
Go to question 67
- ☐ **Private Sector Professionals & Practitioners**
Go to question 57
- ☐ **Members of Non-Profit Institutions / Organizations**
Go to question 52

Questions for Members of Non-Profit Organizations / Institutions

The questions in this section are intended to identify domain experts with expertise on blockchain technology and/or supply chain applications in non-profit organizations.

2. What is your current position? *

Check only one option.

- ☐ Founding Partner
- ☐ Member
- ☐ Other:.....

3. Please mark your areas of specialization. *

Check all that apply.

- ☐ Finance
- ☐ Supply Chain
- ☐ International Trade
- ☐ Governance
- ☐ Law
- ☐ Informatics
- ☐ Logistics
- ☐ Others: _____

4. How many years of experience do you have in your field of expertise? *

5. How many years have you been interested in Blockchain technology?

Check only one option.

- ☐ Less than 1 year
- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years

6. In how many years do you expect blockchain technology to be actively used in supply chain management?

Check only one option.

- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years
- ☐ Other _____

Go to question 73

Questions for Private Sector Professionals

The questions in this section are intended to identify domain experts in the private sector with expertise in blockchain technology and/or supply chain applications.

1. Which sector do you work in?

Check only one option.

- ☐ Finance
- ☐ Information Technology
- ☐ Production
- ☐ Sales and Distribution
- ☐ Consulting Services
- ☐ Research Institutions and Organizations
- ☐ Logistics
- ☐ Other: _____

2. What position do you hold?

Check only one option.

- | | |
|--|---|
| ☐ Information Technology Specialist | ☐ CFO-Chief Financial Officer |
| ☐ Supply Chain Specialist | ☐ CIO- Chief Information Officer |
| ☐ Finance Specialist | ☐ COO- Chief Operating Officer |
| ☐ Counselor | ☐ CTO- Chief Technology Officer |
| ☐ Operation Manager | ☐ CMO-Chief Marketing Officer |
| ☐ CEO-Chief Executive Officer | ☐ Other: _____ |

3. How many years of work experience do you have? *

4. How many years have you been interested in Blockchain technology?

Check only one option.

- ☐ Less than 1 year
- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years

5. In how many years do you expect blockchain technology to be actively used in supply chain management?

Check only one option.

- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years
- ☐ Other: _____

Go to question 73

Questions for Policy Makers & Practitioners

The questions in this section are aimed at getting to know the experts in the policy-making sector who support the development of blockchain technology and policies and who are stakeholders of blockchain projects.

1. In which institution and/or organization do you work? *

Check only one option.

- ☐ Digital Transformation Office of the Presidency of the Republic of Türkiye
- ☐ Republic of Türkiye Ministry of Trade
- ☐ European Bank for Reconstruction and Development
- ☐ ICC Türkiye
- ☐ TUBITAK
- ☐ Other: _____

2. What is your current position in your organization? *

Check only one option.

- ☐ President
- ☐ Vice President
- ☐ Expert
- ☐ Assistant Specialist
- ☐ Other: _____

3. How many years of work experience do you have? *

4. How many years have you been interested in Blockchain technology?

Check only one option.

- ☐ Less than 1 year
- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years

5. In how many years do you expect blockchain technology to be widely used in supply chain management?

Check only one option.

- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years
- ☐ Other

Go to question 73

Academy Specific Questions

The questions in this section are aimed at recognizing experts in the field of blockchain technology and/or supply chain in academia.

1. Academic Title *

Check only one option.

- ☐ Professor
- ☐ Associate Professor
- ☐ Prof. Dr. Lecturer. Prof. Dr.
- ☐ Teaching Assistant
- ☐ Research Assistant

2. Unit / Faculty Area where you work *

Check only one option.

- ☐ Technology
- ☐ Informatics
- ☐ Engineering
- ☐ Social Sciences
- ☐ Law
- ☐ Other: _____

3. Please mark your areas of specialization. *

Check all that apply.

- ☐ Supply Chain Management
- ☐ International Trade
- ☐ Finance

- ☐ Information Technology
- ☐ Production and Operations Management
- ☐ Economy
- ☐ Management Sciences
- ☐ Law
- ☐ Logistics
- ☐ Other: _____

4. Approximately how many years of experience do you have in your field of specialization? *

5. How many years have you been interested in Blockchain technology?

Check only one option.

- ☐ Less than 1 year
- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years

6. In how many years do you expect blockchain technology to be widely used in supply chain management?

Check only one option.

- ☐ 1-3 years
- ☐ 4-6 years
- ☐ 7-9 years
- ☐ More than 10 years
- ☐ Other : _____

go to the question 73.

Expert Opinion Form Completed. Please do not forget to click "Submit" below. you very much for your contribution.

1. You can write other situations, variables or factors that you see as barriers to the adoption of blockchain technology (Optional).

2. We would be happy to receive your comments and suggestions.

Appendix 2. Semi-Structured Interview Form

Opening

Appreciation

Researcher Introduction

Explanation of the Dissertation's Objective

Purpose of the Interview: This interview has two main purposes:

- i. Verification of Existing Findings: To confirm the findings of previous analyses.
- ii. Identification of New Variables: To discover new variables that may provide significant contributions to the study.

Questions for the Expert

Expertise and Background

1. Could you please describe your area of expertise? How many years of experience do you have in Supply Chain Management (SCM) or Information Technology?

Impacts on SCM

2. Could you discuss the importance of blockchain technology in SCM? What kind of transformation do you expect blockchain technology to bring to SCM?
3. What are the impacts of blockchain technology on SCM? Which aspects of blockchain technology are expected to enhance competitive performance in the supply chain context?
4. In addition to its advantages, what potential disadvantages might arise from using blockchain technology in SCM?

Barriers to Adoption in SCM

5. In your opinion, how prepared are organizations in Turkey to adopt blockchain technologies in SCM? Would you say there is significant interest?
6. What are the critical barriers to implementing blockchain technology in SCM in Turkey? What obstacles do organizations face in institutional adoption of blockchain-based SCM systems?
7. How significant do you consider factors such as the complexity of blockchain technology, its immaturity, and high energy costs?

Recommendations

8. What resources can organizations utilize to overcome internal and inter-organizational barriers to blockchain adoption? What are your recommendations on this matter?

9. What changes are needed to make blockchain technology more widespread in SCM? Please evaluate this question in terms of:

- Organizational policies,
- Public policies,
- Managerial strategies,
- Technical approaches.

10. What are your predictions about the future of blockchain technology? Where do you think it will be in five and ten years?

Additional Comments

Is there anything you would like to add about the adoption of blockchain technology?



CURRICULUM VITAE

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EDUCATION STATUS

Degree of Education	Education Place of Study	Year of Study
Doctorate	Sakarya University / Graduate School of Business / Management Information Systems	2018-Currently
Master's	TOBB University of Economics & Technology / Graduate School of Economics and Social Sciences / Economics	2016-2018
Bachelor's	TOBB University of Economics & Technology / Faculty of Economics and Administrative Science/ International Entrepreneurship	2010-2016
Bachelor's (Double Major)	TOBB University of Economics & Technology / Faculty of Economics and Administrative Science / Economics	2013-2016
High School	Bartın Anatolian Teacher High School	2006-2010

JOB EXPERIENCE

Year	Location	Position
2017	Sakarya University	Research Assistant

FOREIGN LANGUAGE

English (86,25/100 YDS Score)

PUBLISHED WORKS

Demir, E., Özsoy, S., & Saygılı, M. (2024). The technological shift towards embedded payments: an examination of young consumers' intention. *Future Business Journal*, 10(1), 1-16.

Özsoy, S., Ergüzel, O. Ş., Ersoy, A. Y., & Saygılı, M. (2022). The impact of digitalization on export of high technology products: A panel data approach. *The Journal of International Trade & Economic Development*, 31(2), 277-298.

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- Özsoy, S., Demir, E., & Ergüzel, O. Ş. (2022). *Tedarik zincirinde dijital dönüşüm: Artırılmış gerçeklik* [oral presentation]. 2nd International Congress on Digital Business, Management & Economics [oral presentation].
- Ozsoy, S., Fazlioglu, B., & Esen, S. (2021). Do FDI and patents drive sophistication of exports? A panel data approach. *Prague Economic Papers*, 30(2), 29, Doi: 10.18267/j.pep.755
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