Arbeidsnotat
Working Paper

2024:4

Abbas Batwa
Alessandro Edoardo G. D. Di Mattia

Blockchain adoption in the automotive industry supply chain : a Unified Theory of Acceptance and Use of Technology (UTAUT) perspective

Høgskolen i Molde
Vitenskapelig høgskole i logistikk

Abbas Batwa
Alessandro Edoardo G. D. Di Mattia

Blockchain adoption in the automotive industry supply chain: a Unified Theory of Acceptance and Use of Technology (UTAUT) perspective

Arbeidsnotat / Working Paper 2024:4

Høgskolen i Molde
Vitenskapelig høgskole i logistikk

Molde University College
Specialized University in Logistics

Molde, Norway 2024

ISSN 1894-4078

ISBN 978-82-7962-364-9 (trykt) ISBN 978-82-7962-365-6 (elektronisk)

Blockchain Adoption in the Automotive Industry Supply Chain: A Unified Theory of Acceptance and Use of Technology (UTAUT) Perspective

Authors:

Abbas Batwa abbas.batwa@tlog.lth.se
PhD Candidate, Lund University, Faculty of Engineering (LTH), Division of Engineering Logistic, Sweden

Alessandro Edoardo G. D. Di Mattia alessandro1.e.g.d.di.mattia@himolde.no
PhD. Candidate, Molde University College, Faculty of Business Administration and Social Sciences, Norway

Group advisor: Professor Arvind Upadhyay, London Metropolitan University, UK

Abstract

Purpose: Blockchain Technology (BCT) promises significant advancements in traceability, transparency, and process efficiency in supply chain management (SCM). Despite BCT's potential and the growing interest in the technology, theoretical exploration of BCT adoption in SCM remains limited, particularly in the automotive industry. This study aims to utilize the Unified Theory of Acceptance and Use of Technology (UTAUT) to explore BCT adoption in the automotive industry's supply chain.

Methodology: This research uses an inductive qualitative approach with multiple case studies. It includes Semi-structured interviews with stakeholders in the automotive sector. The sample includes 15-20 participants who have applied or tested BCT projects, representing diverse BCT features and different supply chain perspectives.

Findings: Expected findings suggest that specific BCT features, such as public versus private blockchains and their consensus mechanisms, significantly impact perceived ease of use and usefulness. These factors will likely influence BCT adoption decisions in the automotive industry's SCM.

Contributions: The study will benefit supply chain managers and decision-makers by helping them better understand key factors influencing BCT adoption, which can aid in developing strategies for successful implementation.

Limitations: The study's qualitative approach and limited sample size may affect the generalizability of the findings. Future research could address these limitations by employing quantitative methods and expanding the sample size to include a broader range of participants across different regions and automotive sub-sectors.

Originality/Value: This study is novel in its focus on BCT adoption in the automotive industry using the UTAUT framework, providing a detailed understanding of individual and organizational acceptance factors that other models, like diffusion theories, may not capture.

Keywords:

Blockchain Technology, Supply Chain Management, Automotive Industry, Technology Adoption, UTAUT

1. Introduction

Blockchain technology (BCT) offers decentralized peer-to-peer transactions and a distributed ledger for its records. This ledger is enabled through immutable and tamper-proof records. Unlike traditional centralized solutions for information flows between Supply Chain (SC) partners, the records in BCT are verified by consensus mechanisms and secured through cryptographic means (Nakamoto, 2008; Beck, 2016; Lumineau et al., 2021). With such features, BCT promises to address the economic, environmental, and social complexities in Supply Chain Management (SCM) (Kshetri, 2018; Wang et al., 2018; Saberi et al., 2019).

BCT application within SCM has attracted significant attention from academic scholars and industry practitioners due to its transformative and disruptive potential (Han and Fang, 2023). According to a Gartner survey, two-thirds of respondents view BCT as a disruptive technology likely to impact business and have plans to invest in it (Burton and Barnes, 2017). To further develop theoretical understanding, Zhu et al. (2022) stated that many researchers have studied theories related to adopting BCT in SCM (Table 1). However, none have exclusively focused on the automotive industry, despite its considerable interest in BCT (Ahmed et al., 2022). One exception is Xu et al. (2022), who studied the TOE (Technology, Organization, and Environment) adoption framework, but only for the German automotive industry.

To address the gap, our study focuses explicitly on the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Technology Acceptance Model (TAM) for the automotive industry. This choice is justified since the automotive industry involves complex and extensive SCM processes. Thousands of parts are used in one car, covering multiple countries and including many stakeholders, such as suppliers, manufacturers, and distributors (Xu et al., 2022).

The complex structure of the automotive industry SC poses considerable difficulties in coordination, traceability, and efficiency. BCT may significantly enhance these areas, especially for OEM (Original Equipment Manufacturer) items. Moreover, the automotive industry is leading the way in technical advancements, making it an appropriate target for studying the integration of emerging technologies such as BCT (Ahmed et al., 2022; Xu et al., 2022).

Table 1: Common Adoption Theories for BCT in SCM (Adopted from Zhu et al. 2022)

Common Adoption Theories of BCT in SCM	Key Findings	References
Innovation/Technology Diffusion Theory	BCT diffusion stages vary significantly by industry	(Grover et al., 2019; Kar and Navin, 2021; Wamba and Queiroz, 2022)
	Early adopters gain a competitive advantage.	(Woodside et al., 2017)
	Permissionless diffusion is more advanced than permissioned BCT diffusion in SCM.	(Helliar et al., 2020)
	Early adopters act as change agents.	(Kouhizadeh and Sarkis, 2018)
Technology-Organization-Environment Framework	Technological factors: benefits, compatibility, transparency, disintermediation, relative advantage.	(Orji et al., 2020; Ghaleb et al., 2021; Seshadrinathan and Chandra, 2021)
	Organizational factors: innovation, learning capability, top management support.	(Orji et al., 2020)
	Environmental factors: competition, government support, partners' readiness, standards uncertainty.	(Ghaleb et al., 2021; Seshadrinathan and Chandra, 2021)
The Unified Theory of Acceptance and Use of Technology Model (TAM/UTAUT)	Adoption factors: performance, effort, social influence, credibility, cost, convenience.	(Hira et al., 2021)
	Task-technology fit affects decisions.	(Liang et al., 2021)
	Trust moderates adoption conditions.	(Sheel and Nath, 2020)

BCT, however, is not one size fits all; it can be categorized into permissionless (public) and permissioned (private) blockchains. Public blockchains like Bitcoin and Ethereum are open to anyone and rely on decentralized consensus mechanisms like proof of work (PoW). These mechanisms ensure security and transparency but can be energy-intensive and slower. In contrast, permissioned (private) blockchains are restricted to specific participants, often within a single organization or a consortium. They typically use more efficient consensus mechanisms like Practical Byzantine Fault Tolerance (PBFT) or Proof of Authority (PoA), which offer faster transaction speeds and greater control but may sacrifice some decentralization and transparency (Helliar et al., 2020; Kumar et al., 2020).

Therefore, this study is novel because it aims to explore BCT adoption using UTAUT, focusing on perceived ease of use and perceived usefulness for different BCT types in automotive SCM. Specifically, we want to answer the following research question:

- *How do BCT features affect its adoption in the automotive industry SCM?*

1.1 Why was the UTAUT theory selected to study BCT adoption in the automotive industry?

UTAUT, developed by Venkatesh et al. (2003), consolidates key variables from eight dominant theories and models, including the Technology Adoption Model (TAM) and Innovation Diffusion Theory (IDT). It focuses on performance expectancy, effort expectancy, social influence, and moderating conditions (Venkatesh et al., 2003). According to Ahmed et al. (2022), widespread adoption in SCM applications is still in its early stages, especially for the automotive industry (e.g., see Table 2). We think it applies more to the agrifood SCM (e.g., Sharma et al., 2023).

Based on the previous discussion, the literature gap, and the purpose of this study, UTAUT was chosen over diffusion theories because it offers a more thorough understanding of the factors influencing individual and organizational acceptance. This makes it a robust and extensively validated framework for predicting technology adoption (Tarhini et al., 2016; Sharma et al., 2023).

Table 2: Examples of BCT projects in the Automotive industry SCM (Adopted from Ahmed et al., 2022)

Organization	Description	News/ Company Websites announcing the BCT project
Porche	Traceability of plastics and tracking of CO2 emissions through the entire SC for OEM	https://shorturl.at/vDb0K
Lamborghini	Provenance of car history and streamlining vehicle authentication processes	https://shorturl.at/L5XPG
BMW	Visibility across the front lights SC	https://shorturl.at/aG2HH

Volvo	Tracing row materials and metals (e.g. Cobalt)	https://shorturl.at/mk8cu
Kia and Hyundai	Monitoring of CO2 emissions for sustainable procurement process	https://shorturl.at/TEeQu

2. Methodology

This study uses an inductive qualitative research approach with multiple case studies to explore the adoption of BCT in the automotive industry. Semi-structured interviews will be conducted with key stakeholders in SCM within the automotive sector. The sample size will include 15-20 participants to ensure comprehensive insights. The case selection criteria include:

- The selected cases should at least have applied or tested BCT projects in the automotive supply chain.
- The selected cases should represent diverse BCT features (e.g., BCT types or consensus mechanisms).
- Different SC companies are preferred to capture varied perspectives (e.g., suppliers, manufacturers, distributors, retailers, and consumers).

The data will be collected through semi-structured interviews, allowing flexibility while covering core questions related to BCT adoption. The interview questions will focus on perceived benefits, challenges, drivers, and contextual factors influencing BCT adoption.

Data analysis will involve coding and cross-case analysis to identify patterns and themes related to BCT ease of use and usefulness by employing methods such as those proposed by Gioia et al. (2013). A comparative analysis will also be conducted to contrast findings and understand varying levels of adoption and influencing factors.

3. Discussion (expected)

The discussion will illustrate the study's empirical findings. Then, compare it with existing literature. This is expected to provide new insights into the adoption dynamics of BCT in the automotive industry. We expect to find that specific BCT features, such as public versus private blockchains and their consensus mechanisms, significantly impact perceived ease of use and perceived usefulness.

These factors are likely to influence adoption decisions among automotive SC stakeholders. The discussion will highlight how performance expectancy, effort expectancy, social influence, and facilitating conditions affect technology adoption.

4. Conclusion (expected)

The conclusion will summarize the key findings, discuss their implications for theory and practice, and provide recommendations for industry stakeholders.

This study is expected to contribute to the theoretical understanding of BCT adoption in complex SCMs such as those in the automotive industry. For instance, by Using UTAUT, we respond to Zhu et al.'s (2022) call for more theoretical research in this field. Practically, the study will benefit supply chain managers and decision-makers by identifying key factors that influence BCT adoption, aiding in developing strategies for successful implementation considering different features of BCT.

Nevertheless, the study has limitations, including the qualitative approach's inherent subjectivity and the limited sample size, which may affect the generalizability of the findings. Future research could address these limitations by employing quantitative methods and expanding the sample size to include a broader range of participants across different regions and automotive sub-sectors.

Reference:

Ahmed, W.A.H., MacCarthy, B.L., & Treiblmaier, H. (2022). Why, where, and how are organizations using blockchain in their supply chains? Motivations, application areas, and contingency factors. International Journal of Operations & Production Management, 42(12), 1995-2028. https://doi.org/10.1108/IJOPM-12-2021-0805

Beck, R., Stenum Czepluch, J., Lollike, N., & Malone, S. (2016). Blockchain–the gateway to trust-free cryptographic transactions. Research Papers, 153. https://aisel.aisnet.org/ecis2016_rp/153

Burton, B., & Barnes, H. (2017). Hype Cycles Highlight Enterprise and Ecosystem Digital Disruptions: A Gartner Trend Insight. Gartner Group, Stamford, CT.

Ghaleb, E.A., Dominic, P., Fati, S.M., & Muneer, A. (2021). The Assessment of Big Data Adoption Readiness with a Technology–Organization–Environment Framework: A Perspective towards Healthcare Employees. Sustainability, 13(15), 8379. https://doi.org/10.3390/su13158379

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. Organizational Research Methods, 16(1), 15-31. https://doi.org/10.1177/1094428112452151

Grover, P., Kar, A.K., & Janssen, M. (2019). Diffusion of blockchain technology: Insights from academic literature and social media analytics. Journal of Enterprise Information Management, 32(5), 735-757. https://doi.org/10.1108/JEIM-06-2018-0132

Han, Y., & Fang, X. (2023). A systematic review of adopting blockchain in supply chain management: bibliometric analysis and theme discussion. International Journal of Production Research, 62(3), 991-1016. https://doi.org/10.1080/00207543.2023.2236241

Helliar, C.V., Crawford, L., Rocca, L., Teodori, C., & Veneziani, M. (2020). Permissionless and permissioned blockchain diffusion. International Journal of Information Management, 54, 102136. https://doi.org/10.1016/j.ijinfomgt.2020.102136

Hira, F.A., Khalid, H., Rasid, S.Z.A., & Alam, M.M. (2021). A Conceptual Framework to Investigate Health Professionals' Blockchain Technology Adoption Readiness in Malaysia. Open International Journal of Informatics, 9(Special Issue 2), 58-66.

Kar, A.K., & Navin, L. (2021). Diffusion of blockchain in the insurance industry: An analysis through the review of academic and trade literature. Telematics and Informatics, 58, 101532. https://doi.org/10.1016/j.tele.2020.101532

Kouhizadeh, M., & Sarkis, J. (2018). Blockchain practices, potentials, and perspectives in greening supply chains. Sustainability, 10(10), 3652. https://doi.org/10.3390/su10103652

Kshetri, N. (2018). Blockchain's roles in meeting key supply chain management objectives. International Journal of Information Management, 39, 80-89. https://doi.org/10.1016/j.ijinfomgt.2017.12.005

Kumar, A., Liu, R., & Shan, Z. (2020). Is blockchain a silver bullet for supply chain management? Technical challenges and research opportunities. Decision Sciences, 51(1), 8-37. https://doi.org/10.1111/deci.12396

Liang, T.-P., Kohli, R., Huang, H.-C., & Li, Z.-L. (2021). What drives the adoption of blockchain technology? A fit-viability perspective. Journal of Management Information Systems, 38(2), 314-337.

Lumineau, F., Wang, W., & Schilke, O. (2021). Blockchain governance – A new way of organizing collaborations? Organization Science, 32(2), 500-521. https://doi.org/10.1287/orsc.2020.1379

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Available at: https://bitcoin.org/bitcoin.pdf (Accessed 28 May 2024).

Orji, I.J., Kusi-Sarpong, S., Huang, S., & Vazquez-Brust, D. (2020). Evaluating the factors that influence blockchain adoption in the freight logistics industry. Transportation Research Part E: Logistics and Transportation Review, 141, 102025. https://doi.org/10.1016/j.tre.2020.102025

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2018). Blockchain technology and its relationships to sustainable supply chain management. International Journal of Production Research, 57(7), 2117-2135. https://doi.org/10.1080/00207543.2018.1533261

Seshadrinathan, S., & Chandra, S. (2021). Exploring Factors Influencing Adoption of Blockchain in Accounting Applications using Technology–Organization–Environment Framework. Journal of International Technology and Information Management, 30(1), 30-68.

Sharma, A., Sharma, A., Singh, R.K., & Bhatia, T. (2023). Blockchain adoption in agri-food supply chain management: an empirical study of the main drivers using extended UTAUT. Business Process Management Journal, 29(3), 737-756. https://doi.org/10.1108/BPMJ-10-2022-0543

Sheel, A., & Nath, V. (2020). Antecedents of blockchain technology adoption intentions in the supply chain. International Journal of Business Innovation and Research, 21(4), 564-584.

Tarhini, A., El-Masri, M., Ali, M., & Serrano, A. (2016). Extending the UTAUT model to understand the customers' Acceptance and use of Internet banking in Lebanon: a structural equation modeling approach. Information Technology & People, 29(4), 830-849. https://doi.org/10.1108/ITP-02-2014-0034

Venkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of information technology: towards a unified view. MIS Quarterly, 27(3), 425-478. https://doi.org/10.2307/30036540

Wang, Y., Han, J., & Beynon-Davies, P. (2018). Understanding blockchain technology for future supply chains: a systematic literature review and research agenda. Supply Chain Management, 24(1), 62-84. https://doi.org/10.1108/SCM-03-2018-0148

Wamba, S.F., & Queiroz, M.M. (2022). Industry 4.0 and the supply chain digitalization: a blockchain diffusion perspective. Production Planning & Control, 33(2-3), 193-210.

Woodside, J.M., Augustine Jr, F.K., & Giberson, W. (2017). Blockchain technology adoption status and strategies. Journal of International Technology and Information Management, 26(2), 65-93.

Xu, X., Tatge, L., Xu, X., & Liu, Y. (2022). Blockchain applications in the supply chain management in the German automotive industry. Production Planning & Control, 1-15. https://doi.org/10.1080/09537287.2022.2044073

Zhu, Q., Bai, C., & Sarkis, J. (2022). Blockchain technology and supply chains: The paradox of the atheoretical research discourse. Transportation Research Part E: Logistics and Transportation Review, 164, 102824. https://doi.org/10.1016/j.tre.2022.102824

This working paper is a result by group work in completion of DRL028

Molde University College
Specialized University in Logistics

HiMolde PhD

DRL028 Blockchain Applications in SCM

Credits: **5 ECTS**

Time: **27 – 31 May 2024**

The course covers fundamental concepts within blockchain technologies (BC) and their applications in supply chain management (SCM). Examples include historical perspectives, BC basics, basic cryptography, peer-to-peer transactions, BC structure, monetary policy and mining, forks and attacks, beyond bitcoin, Ethereum, smart contracts, and enterprise BCs.

Day 1 – May 27, 2024

Welcome & introduction (Bjorn, Anolan, Nitin, Arvind, Alok, Terje)

Each student presents him/her-self, thesis topic and motivation for blockchain (10 min each)

How to Use Publication to Advance Your Academic Career: An International Perspective! (Arvind)

It's All About Collaboration (Research Approaches) (Arvind)

Converting Your Research into a Paper for Publication! Present organization of groups (Alok, Arvind)

Lecture: Blockchain technology and SCM (by Nitin)

Blockchain-SCM Project: Ideas for seminar working paper (led by Alok)

Day 2 – May 28, 2024

Task 1, 2 and 3 Presentations with discussions (max 30 min for each)

Lecture: Blockchain technology and SCM (by Nitin)

Blockchain-SCM Project: Identify a research focus area & gap identification (led by Alok)

Day 3 – May 29, 2024

Task 4, 5 and 6 Presentations with discussions (max 30 min for each)

Lecture: Blockchain technology and SCM (by Nitin)

Blockchain-SCM Project: Research Approach/Method

Day 4 – May 30, 2024

Task 7 and 8 Presentations with discussions (max 30 min for each)

Lecture: Blockchain technology and SCM (by Nitin)

Lecturers presenting their research on Blockchain in SCM (15 min for each)

Blockchain-SCM Project: Working paper writing (led by Alok)

Day 5 – May 31, 2024

Blockchain-SCM Project: Working paper writing (led by Alok)

Blockchain-SCM Project: Presentation of working paper (by each PhD student)

Summing up

Faculty instructors

Nitin Vasant Kale, Professor of Information Technology Practice, University of Southern California, USA
Arvind Upadhyay, Professor of Operations, Logistics and SCM, London Metropolitan University, UK
Alok Mishra, Professor of Data Management & Software Engineering, NTNU, Norway
Bjørn Jæger, Professor of Informatics, Molde University College, Norway
Anolan Milanés, Associate Professor, Molde University College, Norway

Høgskolen i Molde
Vitenskapelig høgskole i logistikk

Høgskolen i Molde
PO.Box 2110
N-6402 Molde
Norway
Tel.: +47 71 21 40 00
post@himolde.no
www.himolde.no