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Article

Blockchain Technology Suitability in Inter-Organisational Workflows: A Thematic Review of E-Payment Process in the Malaysian Public Sector

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ABSTRACT - Blockchain Technology (BCT) is emerging as a transforming tools for inter-organisational collaboration (IOC) workflows, particularly in complex e-payment process within the public sector. In Malaysia, e-payment systems play a significant role in the government's digital transformation agenda under the MYDigital blueprint. However, challenges such as fragmented operations, manual processes and poor communication undermine the efficiency of transactions between government agencies, acquiring banks and the accounting office. The 2022 Auditor General's Report revealed inefficiencies, with frequent delays in transferring over RM6.0 billion in government revenue between 2015 and 2020, caused by service provision failures and operational complexities. BCT's features, including transparency, decentralisation, immutability and automation, position it as a viable solution to these persistent challenges. This study examines trends in BCT-related research from 2017 to 2024 and evaluates key themes relevant to improving IOC workflows. A thematic review (TR) of 35 articles from Scopus and Mendeley was conducted, with thematic analysis performed using ATLAS.ti 24. Seven key themes emerged: autonomous enforcement of penalties, middleware for fragmented systems, automation of manual tasks, service-level agreement (SLA) monitoring platforms, legal aspects of smart contracts, reduction of operational complexity and improved IOC workflow communication. The findings highlight BCT's potential to address IOC workflow challenges and provide actionable insights for enhancing e-payment processes. These insights are invaluable for public sector organisations aiming to adopt BCT to streamline operations and foster collaboration. Additionally, the study identifies critical avenues for future research, emphasizing the importance of innovative solutions in e-payment systems. BCT's adoption promises to significantly improve operational efficiency and inter-organisational trust within the public sector.

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INTRODUCTION

Blockchain Technology (BCT) has gained traction as an innovative tool for improving inter-organisational collaboration inter-organisational collaboration (IOC) workflows, particularly in multi-stakeholder ecosystem like the electronic payment (e-payment) systems (Spahiu et al., 2024). In Malaysia, e-payment systems are a critical component of the government's digital

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transformation initiative (MyDigital Corporation, 2023). Despite these advancements, significant challenges persist in managing IOC workflows. Issues such as fragmented operational systems and reliance on manual processes continue to impair the efficiency of IOC workflow in e-payment process between government agencies, acquiring banks and the accounting office (refer to appendix 1). In 2022, the Auditor General reports the discrepancy of acquiring banks and collection agents to meet service delivery timelines for transferring funds. Over RM6.0 billion in government-collected funds experienced delays between 2015 and 2020 that caused delay on government revenue recognition and non-compliance with Treasury Instruction guidelines (Jabatan Audit Negara Malaysia, 2022).

Hence, to overcome these challenges, various technologies have been identified for enhancing information sharing, operational efficiency and decision-making across organisational boundaries (Elsa & Halil, 2024). Technologies such as Artificial Intelligence (AI) and data analytics are transforming IOC workflows by enabling predictive insights and fostering stronger interdependencies (Bailey et al., 2022). Similarly, technology like Big Data provide real-time data transparency and support automation of routine processes, which facilitates smoother inter-organisational operations (Cepa & Schildt, 2019). Nevertheless, BCT stands out as suitable technology due to its unique decentralised and tamper-resistant ledger that ensures transparency, trust and security (Faisal et al., 2024). By incorporating technologies such as smart contracts, BCT enhances efficiency in IOC workflows by enabling real-time data sharing, automating the enforcement of agreements, minimizing disputes and fostering greater accountability among multiple stakeholders (Nguyen et al., 2023). These capabilities make BCT particularly well-suited for managing the complexities of multi-stakeholder ecosystems (Ahmadisheykhsarmast & Sonmez, 2020). Therefore, these attributes position BCT as a viable solution for addressing the specific challenges inherent to IOC workflows within e-payment processes.

BCT can be defined as a decentralised ledger technology where the transactions are recorded or stored in a shared network without requiring intermediaries for verification (Jackson & Allen, 2024). Technically, it organises transactions into sequentially ordered blocks that are distributed across multiple nodes that ensures traceability and security (Saadan et al., 2024). In contrast to centralised system, BCT operates as a distributed, immutable system, which eliminates reliance on a single controlling authority and instead distributes validation responsibilities across a network of participants (Qadir & Arab, 2023). Thus, this structural difference enables BCT to address the issue of data control monopolies inherent in centralised systems, which have been widely criticized by various stakeholder before (Cai, 2021; Gomaa et al., 2023). Therefore, adopting advanced technologies like BCT to address IOC workflow complexities offers significant potential for improving Malaysia's public sector e-payment processes.

Integrating BCT into public sector transactions has significantly enhanced governance, transparency and operational efficiency. For example, Estonia, widely recognised as a leader in e-governance, has successfully deployed BCT to secure e-voting and improve governmental election (Çabuk et al., 2018). This approach has strengthened transparency and public trust while ensuring data security and integrity. Estonia's success highlights the role of technological infrastructure in supporting privacy and efficiency in digital governance (Khatib et al., 2022). Similarly, Moldova has leveraged BCT to combat corruption and attract foreign investment. Introducing BCT-based land registries has significantly reduced bureaucratic inefficiencies and enhanced property transaction transparency. This case demonstrates BCT's ability to modernise governance frameworks, particularly in countries with developing digital infrastructure (Bustamante et al., 2022). On the other hand, Dubai has set an ambitious goal to become the world's first BCT-powered city by 2025. The Dubai government has implemented BCT in areas such as residency services and secure records management, improving administrative efficiency (Khan et al., 2022). This highlights how proactive government policies can drive technological innovation in the public sector (Goldsby & Hanisch, 2022).

In contrast, the United States has adopted a more experimental approach, with various pilot projects focusing on land registries and healthcare data management. However, issues related to scalability and regulatory harmonisation have slowed large-scale adoption. Despite having a well-established regulatory framework, the lack of cohesive governance has posed challenges to the effective implementation of BCT in public administration (Anyanwu et al., 2023). Meanwhile, China has actively pursued the adoption of BCT to improve urban management and social services. Government-led pilot projects demonstrate a strong commitment to modernising bureaucratic processes (Bustamante et al., 2022). In China's centralised governance model differs from the decentralised approaches seen in Western nations, influencing citizen trust and engagement differently (Walde & Yadav, 2022). However, from a Malaysian perspective, particularly within the public sector context, the implementation of BCT is constrained by the lack of established guidelines and practical use cases to guide stakeholders (Alafnan & Mohdzuki, 2024). Therefore, this study aims to explore the BCT suitability in enhancing IOC workflows within e-payment systems. To date, no studies have explored the intersection of BCT capabilities and e-payment processes in Malaysia's public sector. By employing a thematic review (TR) approach, this study focuses on two key objectives: (i) examining trends and developments in BCT research from 2017 to 2024 and (ii) analyzing relevant themes in BCT literature for improving IOC workflows.

LITERATURE REVIEW

Emerging technologies have increasingly been recognised for their transformative impact on addressing challenges in IOC workflows, particularly in the context of the e-payment process in the Malaysian public sector. These technologies offer significant advancements in information sharing, operational efficiency and decision-making across organisational boundaries, making them vital for streamlining collaborative workflows (Elsa & Halil, 2024). Artificial Intelligence (AI) and data analytics, for instance, have revolutionised how organisations interact by providing real-time insights and predictive analytics. These tools enhance decision-making processes and foster organisational interdependencies, improving collaboration and efficiency in shared workflows (Bailey et al., 2022). Advanced technologies such as Big Data analytics also contribute by enabling organisations to achieve greater transparency and automation in inter-organisational routines through real-time data sharing, essential for addressing complexities in the back-end e-payment process (Cepa & Schildt, 2019).

Cloud computing represents another critical enabler of IOC workflows, offering scalable, accessible platforms that facilitate seamless stakeholder data exchange. The ability to access and update information in real-time helps dissolve traditional data silos and enhances cross-functional collaboration (Onyshchenko et al., 2022). These features are particularly relevant for addressing the operational challenges inherent in the e-payment process, such as fragmented systems and manual reconciliations. However, despite the contributions of these advanced technologies, BCT emerges as uniquely suited to addressing the multifaceted challenges of IOC workflows, particularly in complex environments like e-payment systems within Malaysian public sector agencies.

BCT stands out due to its decentralised, tamper-resistant ledger system that fosters collaborative parties' transparency, trust and security (Faisal et al., 2024). The integration of smart contracts within BCT systems facilitates the automatic enforcement of agreements, enabling real-time data sharing and accountability across multiple stakeholders (Ahmadisheykhsarmast & Sonmez, 2020). Such features are highly advantageous in Malaysian public sector agencies' e-payment processes, where inter-organisational challenges such as SLA discrepancies and lack of monitoring often impede operational efficiency. BCT's ability to automate settlement processes, reduce delays in fund transfers and improve accountability offers a promising solution to these challenges (Dowelani et al., 2023).

Empirical evidence supports BCT's potential in enhancing IOC workflows. Tan and Sundarakani (2021) demonstrated how BCT, combined with smart contracts, could streamline supply chain operations by automating processes and eliminating manual reconciliation. Similarly, studies in the banking sector highlight BCT's ability to improve interbank collaboration through enhanced data visibility and reduced manual interventions (Spahiu et al., 2024; Vedapradha & Ravi, 2023). In the e-payment process, these features could address operational inefficiencies, ensuring timely enforcement of SLAs through automation (Nguyen et al., 2023). Despite these benefits, the adoption of BCT remains in its nascent phase, necessitating further exploration to fully uncover its potential, particularly in application areas like the e-payment systems used by Malaysian public sector agencies.

The government has recognised BCT's transformative potential in Malaysia, as outlined in the National Blockchain Roadmap 2021–2025 under the Ministry of Science, Technology and Innovation (MOSTI) (Ministry of Science Innovation and Technology, 2021). This roadmap emphasises BCT's ability to enhance data integrity, streamline processes and foster transparency across various domains, including the public sector, healthcare and agriculture (Ibiyemi & Olutimehin, 2024). Recent governmental advocacy further underscores the relevance of technology. Prime Minister Datuk Seri Anwar Ibrahim, asserted Malaysia should not be left out to penetrate BCT as part of the new industrial segment diversification (Najib, 2025). Before that, the Deputy Prime Minister, Datuk Seri Dr Ahmad Zahid Hamidi also highlighted BCT's role in improving transparency and combating fraud in the halal certification process, demonstrating its applicability in ensuring trust and accountability in governance systems (Mohamad, 2024).

For Malaysian public sector agencies, the financial domain offers fertile ground for BCT implementation, especially in addressing IOC workflow challenges in the e-payment process. Alafnan and Mohdzuk (2024) identified the financial sector as a high-potential area for BCT adoption, citing its ability to address specific challenges such as manual reconciliations, fragmented workflows and inter-organisational misalignments. The e-payment processes of these agencies exemplify such challenges, where issues in settlement and reconciliation create inefficiencies. By leveraging BCT's decentralised architecture, the IOC workflow in the e-payment process could achieve improved transparency, automation and collaboration.

Despite its potential, a critical research gap exists in understanding the suitability and implementation of BCT, specifically within the IOC workflows of e-payment systems in Malaysian public sector agencies. While studies have highlighted the broad advantages of BCT in financial and operational contexts, there is limited exploration of its role in addressing inter-organisational challenges such as fragmented operations, manual reconciliations and SLA discrepancies within public sector e-payment ecosystems. This gap is particularly pronounced in Malaysia, where the public sector's reliance on traditional and fragmented processes has led to inefficiencies in fund transfers, reconciliation and data sharing. Furthermore, the contextual nuances of Malaysian public sector operations, such as regulatory frameworks and multi-stakeholder environments, have not been adequately examined in existing BCT literature. This research gap underscores the need for a focused investigation to explore how BCT can be tailored and applied to address these unique challenges, thereby improving transparency, efficiency and collaboration across public sector agencies.

METHODOLOGY

This study utilised a non-systematic review approach, differing from systematic reviews in that it emphasizes exploring existing literature to gain insights into a specific issue rather than systematically evaluating outcomes of prior research. This approach is advantageous for researchers as it allows for efficient reading and summarization of content. It aligns with the TR concept, as outlined by Zairul (2020, 2021, 2022) and Zairul and Zaremohzzabieh (2023), which applies thematic analysis techniques to literature reviews. Thematic analysis, as described by Braun

and Clarke (2006), involves identifying patterns and developing themes through a comprehensive examination of the literature. These patterns are then categorized to discern trends, particularly in relation to the suitability of BCT for enhancing IOC workflows in the e-payment process. The primary aim of the study is to analyze and interpret literature to identify emerging trends in the application of BCT within the context of IOC workflows in e-payment process. The selection of literature was guided by specific criteria: (1) publications from 2017 to 2024, (2) sources obtained from the SCOPUS and Mendeley databases and (3) the use of targeted keywords, as detailed in Table 1.

Table 1: Databases' search terms

Database	Selection based on strings criteria	Results
SCOPUS	TITLE-ABS-KEY ("Blockchain*" OR "BCT*" AND "Inter-organi*" OR "Interorgani*" AND "Relation*" OR "Collabor*") AND (LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (OA, "all"))	28
Mendeley	"Blockchain" AND "Collaboration" year: [2017 TO 2024] "BCT" AND "Inter-organisation" year: [2017 TO 2024] "Distributed Ledger Technology" AND "Relation" year: [2017 TO 2024]	27

Adopted from Zairul & Zaremohzzabieh (2023)

The process of creating a thematic review paper can be divided into two distinct phases: (1) quantitative and (2) qualitative. The rigorousness of this process ensures the trustworthiness of the review by following a structured approach outlined in Table 2.

Table 2: Thematic review steps

No.	Step	Descriptions
1	Formulating the research questions	Defining the research question serves as a road map for the succeeding steps. Pertinent parts of the question must be well-specified because they affect search tactics. The nature of the research questions is broad to provide a breadth of coverage.
2	Articles screening	This stage includes identifying relevant research and determining where to search, which phrases to use, which sources and periods to search and which language. Comprehensiveness and breadth are critical in the search. Electronic databases, reference lists, hand-searching of major publications and organisations and conferences are all sources. The breadth of the search is important, but so is the search's practicality. The appropriate keywords will decide the author's desired outcomes.
3	Article filtering	Inclusion and exclusion criteria are used in study selection. These criteria are based on the research question and aim of the study as well as fresh knowledge gained by reading the papers.
4	Cleaning and finalizing selected articles	The metadata of the articles will be double-checked at this stage to ensure that only the relevant articles are picked for the analysis process.
5	Data extraction and synthesis	At this point, a thematic analysis process was used to develop themes based on extensive reading on the subject. To establish consistency, the themes were chosen through an iterative procedure of contrasting and comparing features in the evaluated studies. The information will be input into the ATLAS.ti 24 program, which will extract information for thematic evaluation. To report on the numerical element, the quantitative data were generated using standard bibliometric data. Similar coding techniques were employed by TR in the qualitative investigation for the ensuing topic analysis. It was thought that doing this would fragment and reduce the facts and, in certain cases, alter the dialectic link between reading and writing.

No.	Step	Descriptions
6	Validation on discussed theme	The themes were developed through an iterative process using ATLAS.ti 24, where relevant text was extracted from the reviewed articles. This process involved continuous refinement, including the addition, elimination and merging of text segments to ensure conceptual clarity and coherence. To enhance validity and reliability, the emergent themes underwent peer debriefing and peer review, where independent researchers critically examined the coding structure, thematic patterns and analytical interpretations. This iterative validation process ensured that the themes were theoretically grounded, methodologically rigorous and reflective of the underlying patterns in the data, thereby strengthening the credibility and trustworthiness of the findings.

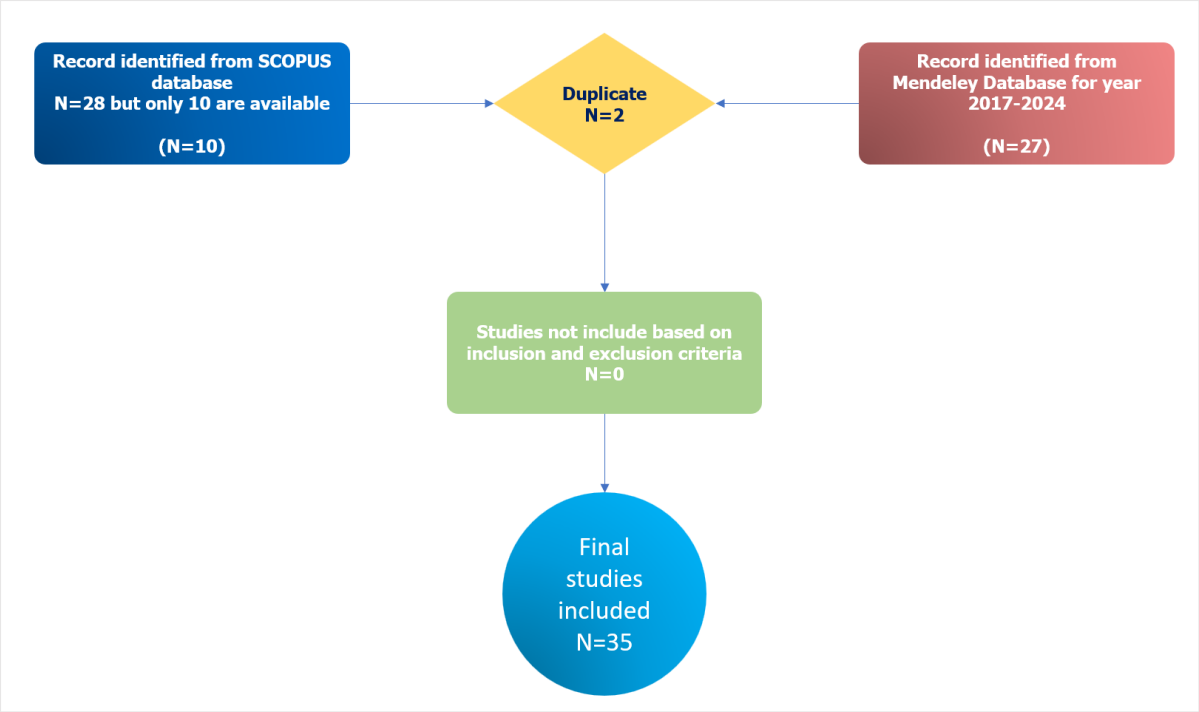
Adopted from Zairul & Zaremohzzabieh (2023)

The selection of articles was guided by the inclusion and exclusion criteria outlined earlier, as depicted in Figure 1. The data collection process was conducted iteratively to ensure consistent and reliable results during the writing phase. Mendeley was chosen for its interdisciplinary scope and broad source availability, while Scopus was selected for its extensive repository of peer-reviewed publications. Filters were applied to refine the search by article type, subject area, language and open access availability. Boolean operators (*) were utilised to search within the Title, Keywords and Abstract fields, employing terms such as Blockchain, Inter-organisation, Relation and Collaboration. This strategy aimed to broaden the scope and ensure comprehensive coverage of relevant literature. The selected articles were subsequently uploaded to Mendeley for processing, which included removing duplicates, standardising author names and verifying metadata accuracy. A final set of 35 articles was exported to ATLAS.ti 24 for in-depth analysis, addressing the following research questions (RQs):

RQ1: What are the patterns and statistics regarding BCT applications in IOC workflows within the e-payment process, particularly in terms of article count, geographical distribution and thematic development in the literature from 2017 to 2024?

RQ2: What themes emerge from the body of literature on BCT applications in IOC workflows within the e-payment process?

The analysis extracted details such as article titles, publication years, authorship, countries of origin, journals, keywords and thematic focus areas. The findings are presented in two sections: quantitative and qualitative. The quantitative analysis focuses on numerical insights displayed through graphs, tables and statistics, while the qualitative analysis explores and develops themes identified from the articles. This review offers valuable insights into the applicability of BCT for enhancing IOC workflows in e-payment systems, highlighting key trends and laying the groundwork for future research.



Adopted from Zairul & Zaremohzzabieh (2023)

Figure 1: Inclusion and exclusion criteria in the thematic review

RESULT

The reviewed studies reveal significant thematic trends in the use of BCT as a tool for addressing challenges in IOC workflows, particularly within financial processes. Many studies highlight BCT's capacity to streamline reconciliation, clearing and settlement operations while enhancing IOC workflows for inter-entity operations. Additionally, blockchain-enabled smart contracts have been widely explored for their ability to automate workflows, enhance data transparency and strengthen accountability across various contexts (Rachad et al., 2022). These findings indicate that BCT facilitates more efficient, secure and transparent workflows, particularly in back-end processes involving multiple stakeholders and complex interactions.

The application of BCT in financial ecosystems underscores its potential to improve IOC workflows by fostering trust, enabling real-time data sharing and supporting process automation. Specific studies emphasize its utility in monitoring SLAs, establishing collaborative platforms and implementing penalty-aware services. Furthermore, BCT's ability to enhance data control and transparency positions it as a promising solution for addressing inefficiencies and building trust in e-payment processes. This thematic analysis provides valuable insights into how blockchain can mitigate challenges associated with fragmented systems, operational complexities and manual reconciliation processes in inter-organisational financial workflows. The findings contribute to the existing body of literature by offering detailed insights into BCT's implementation for improving IOC workflows within e-payment systems.

The key results of this TR are summarized in this section, with the quantitative analysis presented first to support the subsequent qualitative evaluation. The first research question (RQ1) is addressed in the quantitative analysis, while the second research question (RQ2) is explored in the qualitative section. These complementary approaches provide a holistic understanding of BCT's role in addressing IOC workflow challenges.

Quantitative findings

The trend of study considered factors such as publication year, industrial context, research focus and thematic subjects, revealing patterns consistent with BCT applications in the financial domain, thereby addressing RQ1. As illustrated in Figure 2, there was a noticeable rise in the number of relevant articles published between 2021 and 2024, with a significant peak occurring in 2023. However, a slight decrease was noted in 2024, likely due to the review being conducted early in the year, which may have restricted the inclusion of the latest publications. This trend highlights the increasing interest in adopting advanced technologies during this timeframe.

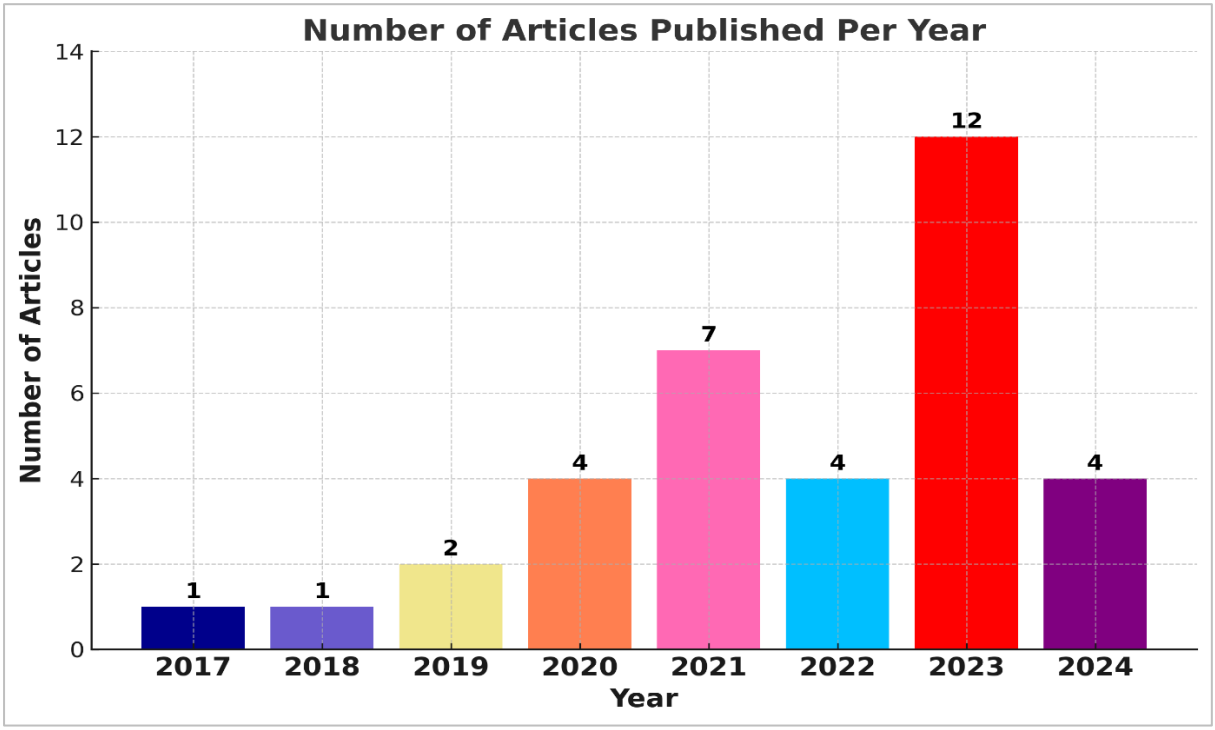


Figure 2: A breakdown of articles by year of publication

Figure **3** depicts publication trends across various countries, illustrates the growing focus on BCT as a tool to enhance inter-organisational workflows (IOCs) in diverse sectors. Developed nations such as the United States, Germany and Italy have taken the lead in exploring BCT's potential to address inefficiencies in areas like financial systems, supply chains and smart contracts. In the United States, research has emphasized BCT's role in improving financial services operations and enhancing supply chain quality and safety standards, demonstrating its ability to streamline data-sharing processes and build trust among stakeholders. Similarly, Germany has made substantial contributions, particularly in integrating BCT into international trade and enforcing smart contracts, effectively addressing issues related to fragmented operations and limited transparency in IOC workflows. In Italy, studies frequently focus on BCT's applications in financial and supply chain sectors, exploring its use in collaborative platforms and fraud mitigation in accounting systems, thereby reinforcing its value in overcoming coordination challenges between organisations.

Emerging economies have also contributed significantly, particularly in contexts where IOC workflows face inefficiencies and a lack of trust. In India, research has highlighted BCT's role in improving inter-agency collaboration and data control within government operations and banking reconciliation processes. In Bangladesh, studies have explored regulatory challenges surrounding BCT adoption in financial reporting, emphasizing the importance of transparent data exchange in reducing fraud risks. Research from Morocco has examined the use of BCT in healthcare

workflows, particularly for managing large-scale processes like those necessitated by the COVID-19 pandemic. These studies from developing countries underscore BCT's adaptability in addressing unique inter-organisational challenges, including fragmented communication and inconsistent SLAs, further illustrating its global relevance and potential.

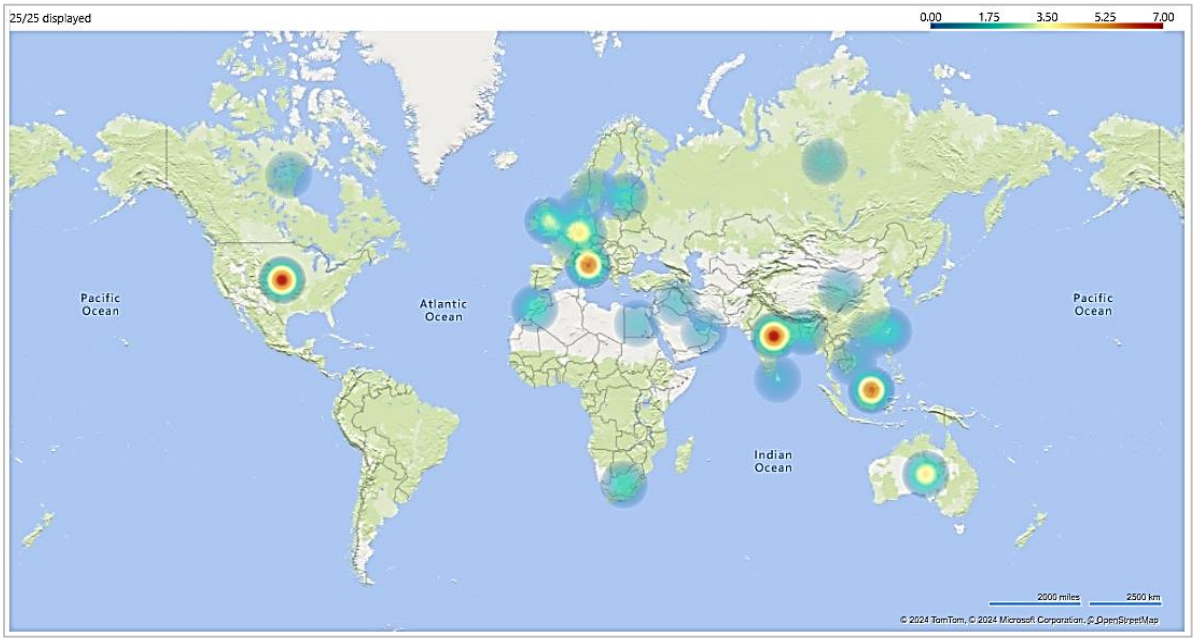


Figure 3: Geographical dispersion on the article published

In Malaysia, research increasingly highlights the potential of BCT to enhance IOC workflows across key sectors. For instance, studies have examined its application in freight booking and banking reconciliation, depicting how BCT's features—such as distributed ledger systems and automated contract enforcement—can mitigate operational inefficiencies, foster trust and improve coordination among stakeholders. These findings align with Malaysia's broader efforts to modernize workflows in areas like transportation, finance and public administration, where effective IOC is essential. BCT is particularly viewed as a viable solution for addressing coordination issues, increasing transparency and enabling seamless data exchange between entities such as government agencies, financial institutions and private sector players.

Globally, literature from both developed and developing countries highlights the widespread relevance of BCT in transforming IOC workflows. While advanced economies primarily focus on leveraging BCT for innovation and enhancing efficiency in mature systems, developing nations emphasize its potential to address fundamental inefficiencies in inter-organisational processes. Malaysia's contribution to this discourse lies in its emphasis on practical applications of BCT to address operational gaps, especially in areas where collaboration among multiple organisations is critical to workflow optimization. The intersection of global and regional perspectives reinforces BCT's stand-out as a powerful tool for fostering efficient, transparent and trust-driven IOC workflows across diverse domains.

Table 3 outlines the themes identified in this study, which can be categorized as follows; T01: Autonomous penalties enforcement, highlighting BCT's capability to implement self-executing mechanisms for ensuring compliance, T02: Middleware for fragmented systems, addressing the challenges of integrating diverse and disconnected systems, T03: Automation of manual processes, focusing on minimizing inefficiencies in existing workflows, T04: SLA monitoring platform, emphasizing enhanced accountability and adherence to SLAs, T05: Legality of smart contracts, exploring concerns about the enforceability and reliability of automated

agreements, T06: Reduction of operational complexity, showcasing how BCT simplifies processes to improve overall workflow efficiency and T07: Improved IOC workflow communication, demonstrating BCT's role in facilitating better data exchange and collaboration among stakeholders. Collectively, these themes underscore BCT's significant potential to resolve a range of challenges associated with inter-organisational workflows, enhancing efficiency, transparency and trust.

Table 3: Author vs. Themes

No	Authors	Theme code*						
		T01	**T02**	**T03**	**T04**	**T05**	**T06**	**T07**
1	Bosco et al. (2024)					/		
2	Spahiu et al. (2024)						/	
3	Akter et al. (2024)					/	/	
4	Sharma et al. (2024)						/	
5	Dwivedi et al. (2023)					/		
6	Jahagirdar (2023)	/						
7	Nguyen et al. (2023)	/						
8	Odunlami and Samuel (2023)		/					
9	Chowdhury et al. (2023)			/				
10	Kumar et al. (2023)			/				
11	Vedapradha and Ravi (2023)			/				/
12	Hacker et al. (2023)							/
13	Khelifi et al. (2023)				/			
14	Sabri et al. (2023)				/			
15	Dowelani et al. (2023)						/	
16	Du et al. (2023)				/			
17	Kshetri (2022)							/
18	Rachad et al. (2022)	/						
19	Centobelli et al. (2022)			/				
20	Kang et al. (2022)							/
21	Tan and Sundarakani (2021)		/					
22	Roszkowska (Roszkowska, 2021)		/					
23	Udokwu et al. (2021)							/
24	Weerakoon and Chandanie (2021)						/	
25	Kassmi and Jarir (2021)				/			
26	Nanayakkara et al. (2021)							/
27	Zainutdinova (2021)					/		
28	Nikbakht et al. (2020)			/			/	
29	Tsai et al. (2020)		/					
30	Sandner et al. (2020)		/					
31	Drummer and Neumann (2020)					/		
32	Chiu and Koeppl (2019)		/					
33	Chang et al. (2019)							/
34	Neidhardt et al. (2018)				/			
35	Treleaven et al. (2017)			/				

(*) T01-Autonomous penalties enforcement; T02-Middleware for fragmented system; T03-Automation on the manual process; T04-SLA monitoring platform; T05-Legality of smart contract; T06-Reduce operational complexity and T07-Improve IOC workflow communication

Table 4 highlights blockchain research across a range of disciplines. In **Accounting and Finance**, journals like the *International Journal of Accounting Information Systems* explore its applications in enhancing financial processes and preventing fraud. In **Information Systems and**

Technology, publications such as the *Journal of Information Technology* delve into blockchain's contributions to data security and the implementation of smart contracts. Research in **Management and Business**, including studies in the *California Management Review*, focuses on blockchain's influence on operational efficiency and supply chain management. In the field of **Law and Compliance**, studies address the regulatory challenges associated with blockchain adoption. Meanwhile, **Engineering and Construction** research, found in journals like *Construction Innovation*, emphasizes improvements in payment systems and project management. Finally, **General Science** publications, such as *Administrative Sciences*, offer broader perspectives on blockchain's impact on organisational strategies and technological advancements.

Table 4: Periodical vs. year of publications

Publications	2024	2023	2022	2021	2020	2019	2018	2017	Total
International Journal of Accounting Information Systems	1								**1**
Journal of Global Operations and Strategic Sourcing				1					**1**
Management and Accounting Review		1							**1**
Administrative Sciences	1								**1**
Accounting, Auditing and Accountability Journal			1						**1**
Industrial Management and Data Systems						1			**1**
The Review of Financial Studies						1			**1**
Review of Economics and Finance		1							**1**
Acta Commercii - Independent Research Journal in the Management Sciences		1							**1**
Journal of Information Technology					1				**1**
California Management Review		1							**1**
Journal of Universal Computer Science		1							**1**
California Management Review		1							**1**
California State University, San Bernardino		1							**1**
Construction Innovation			1						**1**
International Journal of Advanced Computer Science and Applications				1					**1**
AIP Conference Proceedings		1							**1**
The Rise of Blockchains			1						**1**
International Journal of Law and Management		1							**1**
Informatics				1					**1**
CEUR Workshop Proceedings							1		**1**
IEEE Access		1							**1**
Managerial Finance					1				**1**
Uppsala University		1							**1**
Proceedings - 2022 9th International Conference on Wireless Networks and Mobile Communications			1						**1**
Journal of Accounting and Organizational Change				1					**1**

Publications	2024	2023	2022	2021	2020	2019	2018	2017	Total
Future Internet					1				**1**
Journal of Computer Information Systems	1								**1**
International Journal of Electronic Commerce	1								**1**
Computer								1	**1**
Journal of Risk Finance					1				**1**
International Journal of Information Technology				1					**1**
Innovation and Management Review		1							**1**
World Construction Symposium				1					**1**
Journal of Siberian Federal University. Humanities & Social Sciences				1					**1**
Total	**4**	**12**	**4**	**7**	**4**	**2**	**1**	**1**	**35**

In summary, this section addresses RQ1 by highlighting research trends in the application of BCT to the IOC workflow within the e-payment process. These trends align with the broader broader challenges faced by the organisation in managing the IOC workflow in the e-payment domain. Furthermore, this study discusses the suitability of BCT in addressing these workflow challenges (see Figure 4).

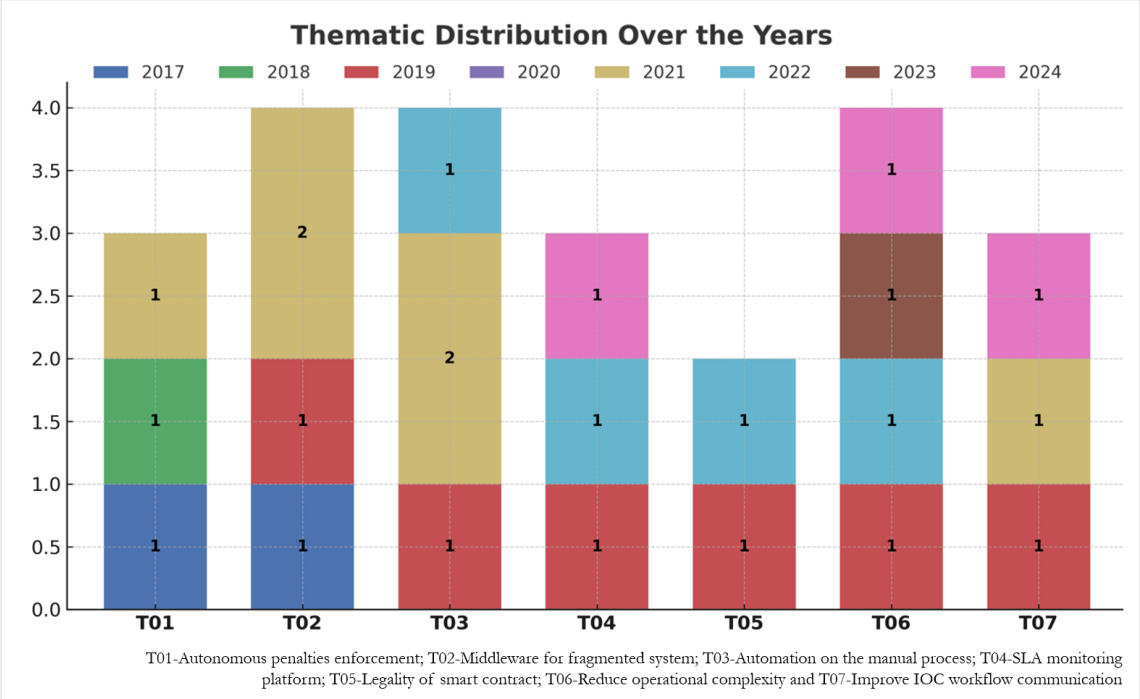


Figure 4: Themes of the study and publication years

Qualitative findings

This TR paper analyzed publications and identified patterns related to the application of BCT in IOC workflows. However, it did not provide specific solutions for integrating BCT into the e-payment process within IOC workflows. Through multiple iterations, initial codes were identified, refined and organised into categories. Codes that were infrequently referenced and did not align

with any specific topic were excluded, as the focus of this study was on aspects that have been thoroughly examined and discussed in existing research.

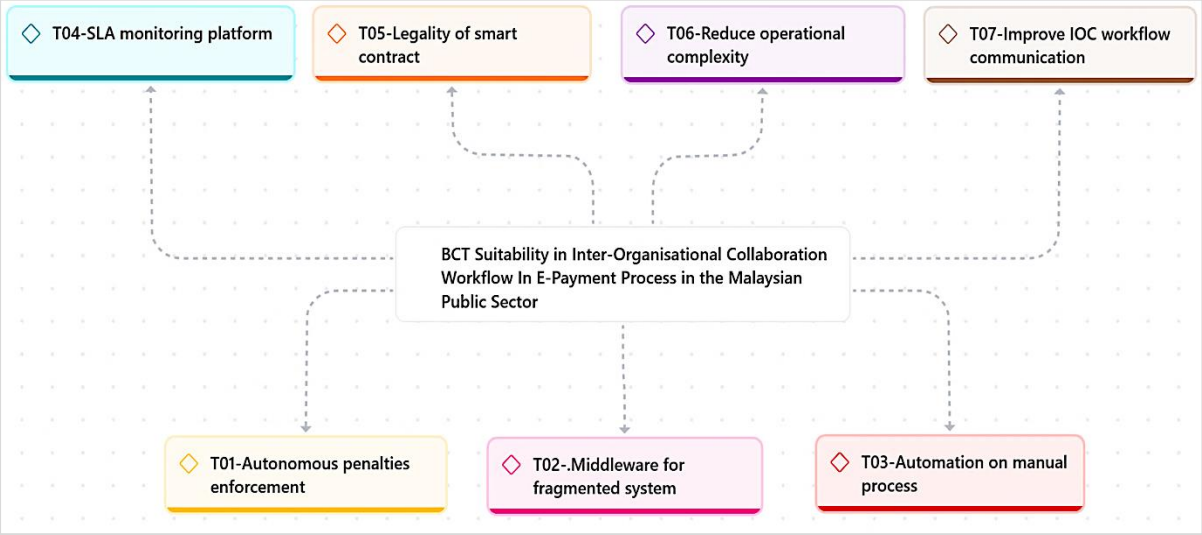


Figure 5: Overall network to answer Research Question 2

Quantitative findings that lacked statistical significance were excluded from the analysis. In addition, general sociodemographic characteristics were not considered, as they may not be universally relevant across all contexts. Ultimately, seven key themes were identified: T01 - Autonomous penalties enforcement, T02 - Middleware for fragmented systems, T03 - Automation of manual processes, T04 - SLA monitoring platform, T05 - Legality of smart contracts, T06 - Reduction of operational complexity and T07 - Improved IOC workflow communication. Each of these themes is examined in greater depth in the subsequent sections. Results that fall outside these themes or were derived from articles not directly evaluated in this study are referenced as needed for descriptive purposes (see Figure 5).

T01-Autonomous penalties enforcement

The application of BCT to enhance IOC workflows, particularly for enforcing SLAs, is gaining considerable momentum across various sectors (refer to Figure 6). In their study, Nguyen et al. (2023) introduced PenChain, a blockchain-based platform designed to support SLA-focused service delivery. Utilising BCT, PenChain automates SLA enforcement through machine-readable logic, ensuring penalties are programmatically applied when service obligations are unmet. Its implementation in sectors such as precision agriculture and automotive manufacturing demonstrates the platform's scalability, transparency and ability to uphold service quality standards. Similarly, Rachad et al. (2022) examined the role of BCT in automating SLA execution, specifically within cloud computing systems used by healthcare SMEs. By integrating smart contracts, BCT facilitates real-time data transparency and accountability, mitigating fraud and errors while decentralising trust. The study also highlights key challenges, including regulatory uncertainties, interoperability issues and privacy concerns, advocating for further research to refine BCT integration in diverse organisational settings.

In meantime, Jahagirdar (2023) explored SLA enforcement in healthcare cloud partnerships, with a focus on the challenges faced by SMEs with limited resources and technical expertise. This study demonstrated how BCT-powered smart contracts can enhance SLA compliance by automating processes, ensuring data integrity and fostering trust among stakeholders. Despite persistent issues related to governance, costs and user adoption, the findings underscore BCT's

potential to enhance operational scalability and accountability, positioning it as a transformative tool for SLA management in resource-constrained environments.

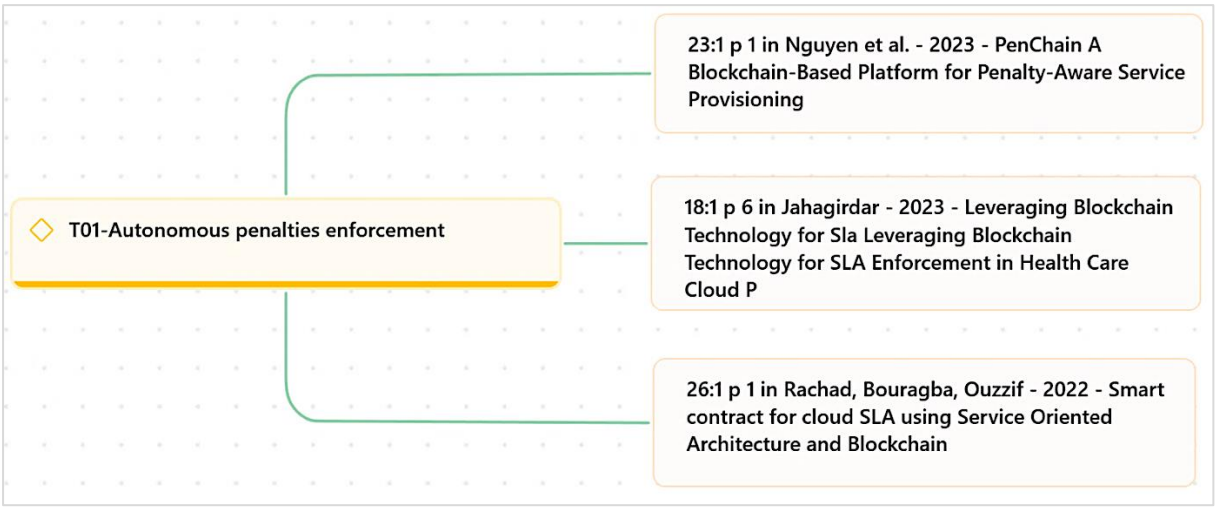


Figure 6: T01-Autonomous penalties enforcement

Mutually, these studies highlight BCT's effectiveness in addressing SLA enforcement challenges within multi-stakeholder environments. By enabling autonomous penalty enforcement, BCT strengthens compliance mechanisms while fostering trust and improving efficiency in IOC workflows. This theme is particularly significant for enhancing IOC workflows within the e-payment processes of Malaysia's public sector, where challenges such as those identified in the Auditor General of Malaysia's findings reflect similar issues of negligence and inefficiency.

T02-Middleware for fragmented operation system

Fragmented systems result in siloed operations, where organisations operate independently, impeding the efficiency and seamless flow of IOC workflows. Such environments often experience challenges in communication and data exchange, leading to delays, errors and operational inefficiencies (Wong et al., 2024). Within enterprise resource planning (ERP) systems, BCT has demonstrated its ability to enhance process efficiency by standardising and consolidating data (Atik & Kelten, 2021), thereby supporting more informed decision-making for strategic positions like Chief Financial Officers (Sandner et al., 2020). In settlement and clearing industry, the Guangdong Clearing House (GCH) serves as an example of how BCT enables participants to maintain independent databases while securely sharing information across a network, promoting collaboration while preserving data autonomy (Tsai et al., 2020). By decentralising data-sharing mechanisms and automating essential processes, BCT eliminates the reliance on centralised post-trade infrastructure, which is often associated with manual reconciliation and labor-intensive activities (Chiu & Koeppl, 2019). Given these advantages, BCT holds substantial promise for optimising IOC workflows in the e-payment systems of Malaysian public sector agencies, where fragmented systems create significant operational challenges. Through automation and standardisation, BCT can address these issues, reducing fragmentation risks and enabling more transparent and efficient e-payment processes (refer to Figure 7).

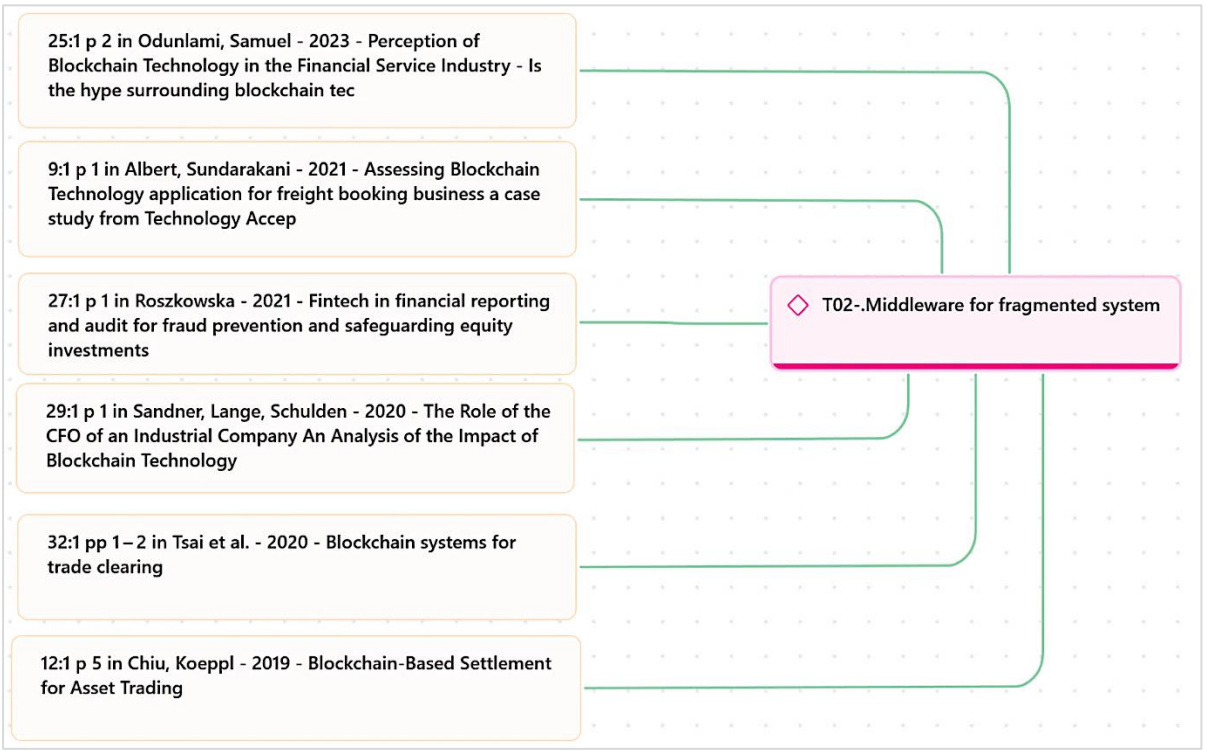


Figure 7: T02-Middleware for fragmented system

Despite its potential, challenges related to standardisation and interoperability present significant obstacles to the successful implementation of BCT (Odunlami & Samuel, 2023). For instance, in accounting domain, large-scale data processing requires seamless system interoperability to facilitate high-volume data transaction (Roszkowska, 2021). However, many current BCT networks operate in isolation, resulting in interoperability issues such as differences in consensus mechanisms, transaction protocols and smart contract capabilities (Tan & Sundarakani, 2021). Integration of legacy operation system with Application Programming Interfaces (APIs) have been adopted by global established corporation such as IBM, Microsoft and GS1 to enhance interoperability in BCT applications in supply chain management. Therefore, addressing these challenges is crucial for unlocking the full potential of BCT. This study found that the application of BCT as middleware can be effectively utilised to resolve fragmentation issues within the IOC workflows of Malaysian public sector agencies, thereby enhancing the efficiency and transparency of the e-payment process.

T03-Automation on the manual process

BCT offers inherent capabilities for automating routine and fixed operations in environments that heavily rely on manual processes (see Figure 8). For example, in accounting, manual reconciliation tasks can be replaced by automated processes using BCT, streamlining operations while simultaneously reducing the likelihood of human error (Centobelli et al., 2022). Hence, BCT not only enhances efficiency but enables organisations to reallocate personnel to more strategic, value-driven roles and boosting overall productivity (Chowdhury et al., 2023). In the context of Malaysian public sector, automating the reconciliation of e-payment transactions is expected to reduce error rates and improve operational performance, enabling management to relocate personnel to more critical function. As a result, the organisation could minimize operational cost and creating a more seamless and efficient IOC workflow (Kostić & Sedej, 2022). Therefore, these cost savings are anticipated to optimize IOC workflows among agencies such as public sector

agencies, acquiring banks and accounting offices, ensuring smoother and more efficient operations.

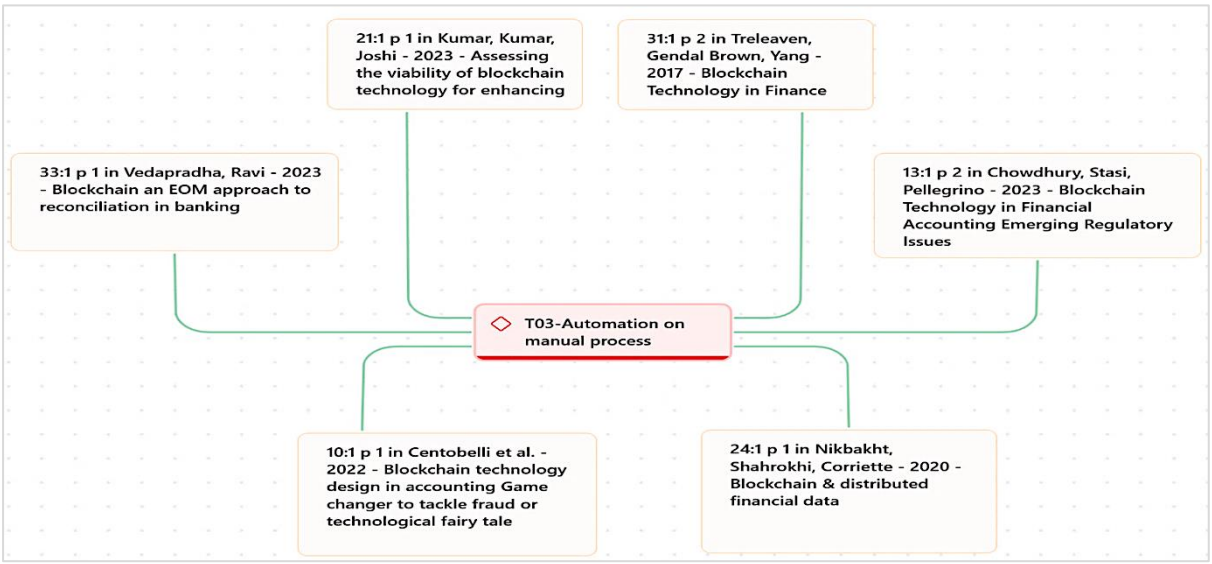


Figure 8: T03-Automation on the manual process

Furthermore, Kumar et al. (2023) highlighted smart contracts embedded in BCT can reduce transaction costs and improve processing speeds, as evidenced by their implementation in court case management systems. In the e-payment domain, BCT enhances transparency by enabling banks to track detailed transactional data such as type (e.g., deposits, withdrawals, or wire transfers), amount and timestamps (Nikbakht et al., 2020). Smart contracts application in BCT can automate reconciliation processes between public sector agencies, acquiring banks and accounting offices, expediting fund transfers and revenue recognition while ensuring accuracy and traceability for high-volume transactions. This automation would enable Malaysian public sector agencies to handle complex e-payment operations more effectively.

For full automation, all parties within a network must be interconnected. Vedapradha and Ravi (2023) explain that BCT facilitate seamless transaction updates between investment banks and their counterparties, with discrepancies automatically managed through smart contracts (Treleaven et al., 2017). However, successful implementation also requires robust governance frameworks and clear operational guidelines to ensure it can be understandable by the employee (Schuetz & Venkatesh, 2020). In Malaysia's public sector context, governance structures are strictly guided through treasury circulars and operational guidelines. Therefore, a significant challenge lies in converting these operational guideline into programmable formats for BCT integration. Moreover, legal consent from relevant boards and a strategic blueprint for the technological workflow are essential to ensure compliance with data regulations, improve reporting processes and maintain transparency and accuracy (Arjun & Suprabha, 2020). Hence, aligning BCT implementation with existing legal and operational practice enables public sector agencies in Malaysia to mitigate risks related to non-compliance and data inaccuracies, thereby facilitating the successful implementation of automated workflows.

T04-SLA monitoring platform

Service level agreements (SLAs) is a critical tool in evaluating the quality of service delivery, particularly in online transactions. SLAs typically formalize the expectations and terms agreed upon by contracting parties (see Figure 9). However, these agreements have traditionally been managed through manual processes, which are often susceptible to delays, errors and enforcement lapses (Khelifi et al., 2023). The 2022 Auditor General's Report highlighted significant issues faced by

Malaysian public sector agencies in enforcing SLA terms, particularly regarding delays in fund transfers by acquiring banks and collection agents. BCT offers a transformative approach by automating SLA monitoring, thereby improving transparency and fostering trust (refer to Figure 9). As demonstrated by Neidhardt et al. (2018), real-time data sharing enabled by BCT in cloud-based environments enhances SLA compliance. Similarly, Sabri et al. (2023) found BCT enables parent companies to monitor inter-company transactions in real-time, replacing the traditional monthly review process. Malaysian public sector agencies could adopt BCT to enable real-time SLA monitoring with acquiring banks and accounting offices, addressing current inefficiencies.

BCT's decentralised and tamper-proof characteristics promote accountability and significantly reduce the risk of fraud in financial operations (Chowdhury et al., 2023). Integrating BCT into financial reporting systems can improve both efficiency and transparency, making it a relevant solution for agencies aiming to optimize IOC workflows. Chowdhury's analysis emphasises the need for policymakers and regulators to address challenges such as standardisation, scalability and privacy to facilitate widespread adoption. Similarly, Kumar et al. (2023) demonstrate how BCT's immutable and transparent record-keeping enhances the efficiency of the judicial system, a benefit that also extends to SLA monitoring by reducing manual interventions and lowering transaction costs.

Furthermore, Du et al. (2023) discuss how BCT eliminates administrative costs and enhances information sharing in supply chains, a feature highly applicable to SLA monitoring platforms. By digitising and automating compliance data, BCT facilitates transparency and seamless collaboration among stakeholders, including auditors and third-party certifiers. These capabilities can be adapted to Malaysian public sector e-payment systems, enabling automated SLA monitoring to ensure compliance with agreed terms, minimize delays in fund transfers and enhance overall workflow efficiency. However, addressing interoperability and governance challenges remains crucial. Establishing robust governance frameworks and effectively integrating BCT with existing systems will be essential to realise these benefits and achieve successful implementation.

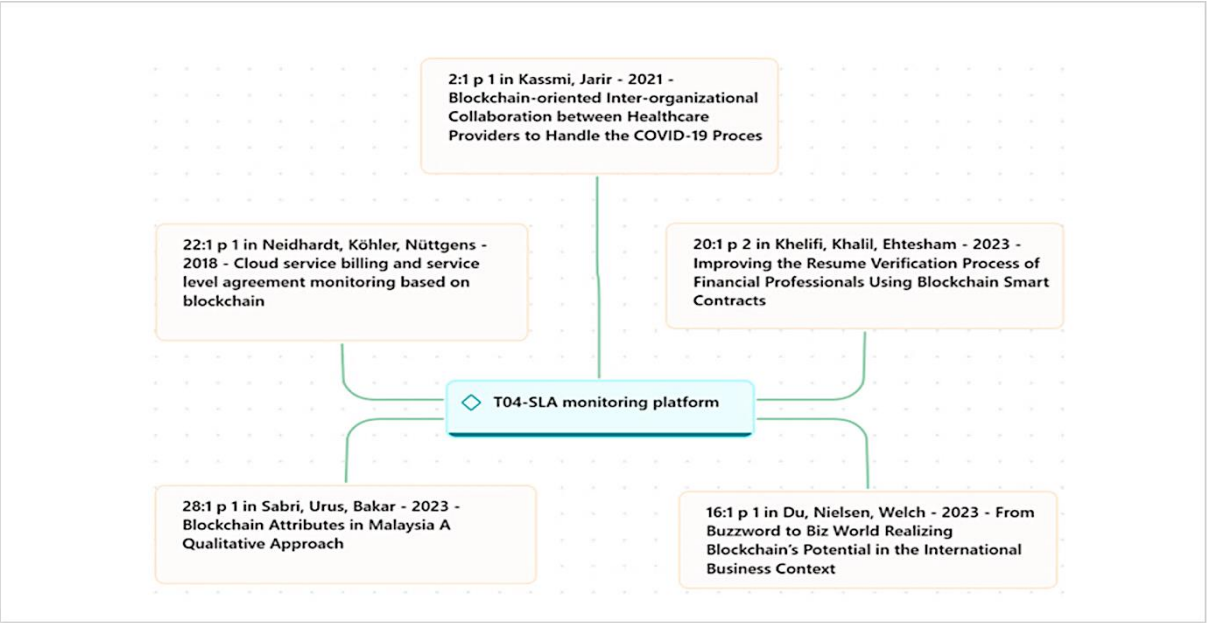


Figure 9: T04-SLA monitoring platform

T05-Legality of smart contract

The integration of SLA terms into smart contracts, incorporating elements such as service provisions, timeframes and penalty clauses for violations, able to improve the monitoring and enforcement of IOC workflows (see

Figure **10**). This capability is particularly relevant to the Malaysian public sector, where ensuring compliance with SLAs in back-end e-payment processes remains a significant challenge. The Ministry of Finance has emphasised the importance of imposing penalties on acquiring banks that fail to meet SLA obligations. By leveraging BCT, public sector agencies could enable real-time monitoring of SLAs, automate penalty enforcement and enhance accountability. This approach has the potential to increase SLA compliance, streamline back-end e-payment operations and promptly address any discrepancies or delays.

However, implementing BCT-based smart contracts raises complex legal and regulatory considerations (Drummer & Neumann, 2020). While smart contracts are recognized for their automated execution and termination features, their compatibility with existing legal frameworks remains a subject of ongoing debate (Zainutdinova, 2021). Key challenges include potential conflicts with existing contract laws, issues related to the technical design of smart contracts and questions regarding their suitability for widespread adoption. Dwivedi et al. (2022) identify three critical aspects of smart contract suitability: semantic, workflow and expressiveness. Semantic suitability pertains to the the inclusion of essential elements, such as the involved parties, terms, and exchanges. Workflow suitability requires alignment with established operational processes, incorporating control-flow, data-flow, resource-flow and exception handling. Expressiveness refers to the extent of technical programming necessary to ensure smart contracts' functionality and accuracy.

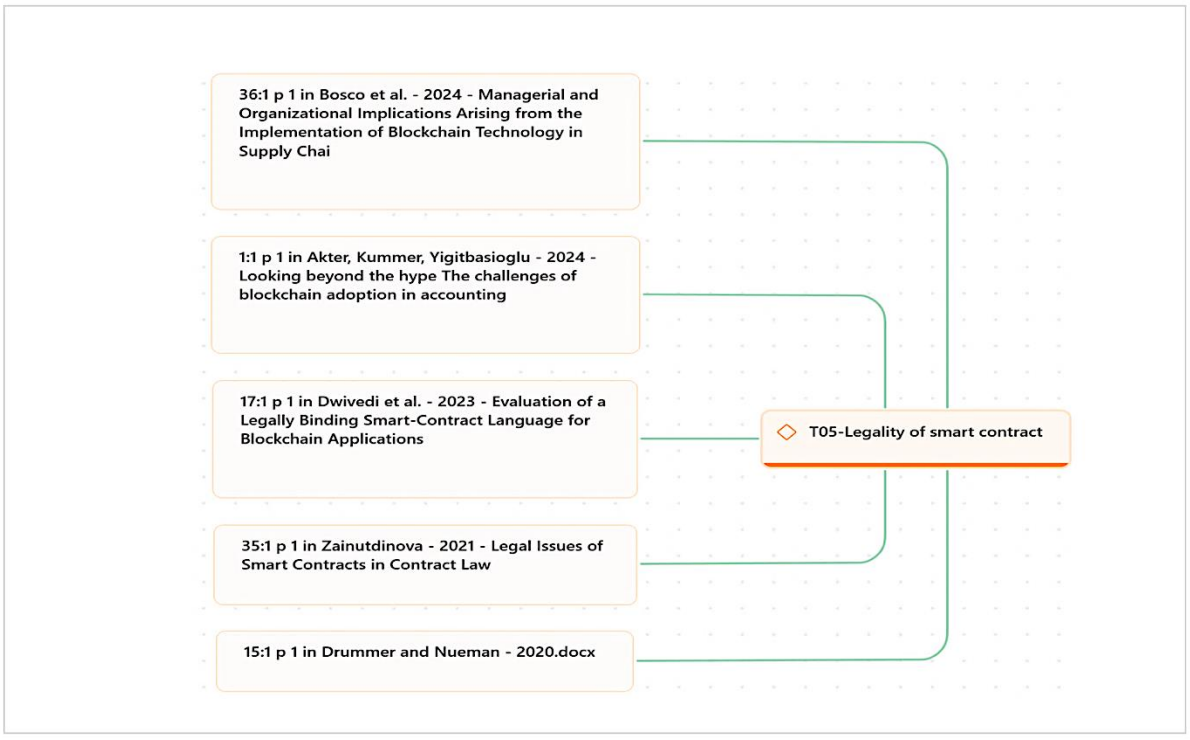


Figure 10: T05-Legality of smart contract

In Malaysia's public sector context, the concept of smart contracts is not entirely new. Online contract implementation in ePerolehan have embedded aspects of smart contracts, although not on a BCT platform. Thus, implementing BCT-based smart contracts in the e-payment process would require thorough understanding and buy-in from public sector officers, given concerns around data privacy and confidentiality. In the meantime, Akter et al. (2024) highlight resistance to sharing sensitive data on public BCT networks due to governance and compliance risks. This issue is particularly pertinent given the existence of stringent privacy laws,

such as the Privacy Act in many jurisdictions, which impose strict data handling requirements and may pose legal challenges for BCT implementation (refer to Figure 10). In contrast, Bosco et al. (2024) argue that application of smart contract and BCT can strengthen contract execution by certifying digital documents through distributed ledgers, thereby ensuring the reliability, immutability and security of information. These attributes, therefore, foster trust in data exchanges across supply chains-a benefit that could also extend to financial and e-payment workflows within the Malaysian public sector.

T06-Reduce operational complexity

BCT offers a powerful solution for reducing operational complexity through its decentralised, transparent and immutable framework (see Figure 11). By streamlining workflows, minimising inefficiencies and improving coordination among multiple organisations, BCT has proven its effectiveness in high-volume transaction environments (Mohammed et al., 2023). For instance, BCT has been successfully implemented in trade clearing and settlement systems, managing hundreds of thousands of transactions while addressing challenges related to performance, privacy and scalability (Nikbakht et al., 2020). This capability is particularly relevant for Malaysian public sector agencies, which also handle substantial transaction volumes. In a decentralised framework, processes such as settlement can be automated and executed transparently, reducing delays and operational inefficiencies (Dowelani et al., 2023).

However, the adoption of fully decentralised systems in the highly regulated public sector poses challenges. Removing centralised authority in such settings is often a complex and lengthy process (Akter et al., 2024). Sharma et al. (2024) note that government agencies frequently operate in silos due to fragmented systems, an issue BCT can address. Nonetheless, resistance to relinquishing centralised regulatory oversight remains a significant barrier. For instance, cross-border fund transfers continue to require validation from central banks, highlighting the indispensable role of regulatory authorities (Weerakoon & Chandanie, 2021). Instead, eliminating central oversight, a hybrid approach can be adopted, wherein BCT complements existing regulatory mechanisms. This model maintains oversight while enhancing efficiency and collaboration within a partially decentralised framework (Gomaa et al., 2023). Such an approach would enable Malaysian public sector agencies to improve operational efficiency without compromising critical regulatory functions.

Moreover, as organisations increasingly adopt collaborative digital tools, BCT has gained prominence for facilitating inter-organisational workflows (Spahiu et al., 2024). The Spunta Banca DLT Project in Italy illustrates the successful implementation of a permissioned BCT platform for interbank reconciliation, highlighting the importance of integrating diverse organisational requirements while adhering to decentralised governance structures. The project's success was underpinned by a gradual legitimacy-building process that incorporated pragmatic, normative and cognitive elements. This phased approach may serve as a valuable model for Malaysian public sector agencies aiming to implement BCT to enhance IOC workflows.

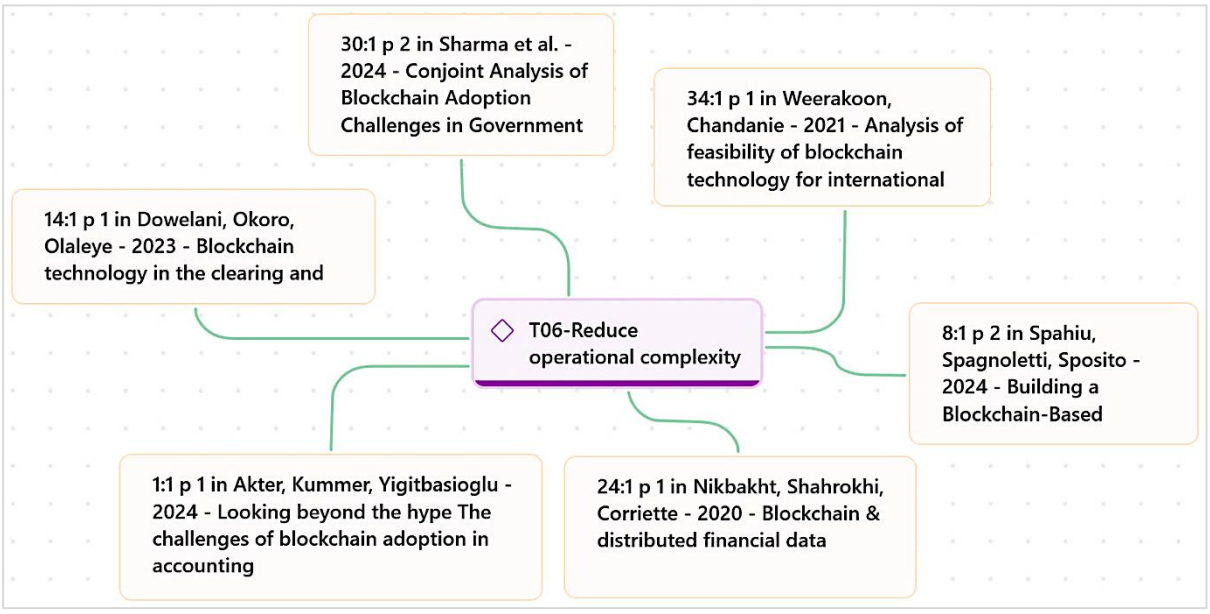


Figure 11: T06-Reduce operational complexity

Nonetheless, BCT faces limitations in transaction throughput, which is a critical performance metric. Current blockchain systems, such as Bitcoin, can process only seven transactions per second, compared to VISA's average of 1,700 (Sharma et al., 2024). This low throughput remains a significant barrier to BCT adoption, influenced by factors such as the consensus mechanism, the number of validators and the complexity of applications. Overcoming these limitations is essential to fully leverage BCT's potential for reducing operational complexity in high-transaction environments.

T07-Improve IOC workflow communication

Fragmented systems pose significant challenges to communication in IOC workflows, resulting in delays, inefficiencies and increased operational costs (see Figure 12). Poor stakeholder communication often leads to project delays, budget overruns and incomplete deliverables (García de Soto et al., 2018; Yap et al., 2019). While traditional systems aim to coordinate supply chain operations and reduce costs (Treiblmaier et al., 2021), they frequently fail to address the inherent fragmentation in complex back-end e-payment processes. This raises questions about the effectiveness of these systems in managing such operations. BCT has emerged as a promising solution for improving communication in IOC workflows. Kang et al. (2022) illustrate how BCT and smart contracts streamline inter-organisational communication, such as automating letters of credit in trade finance supply chains. These capabilities are particularly relevant for Malaysian public sector agencies, which manage diverse stakeholders, including acquiring banks and accounting offices, in e-payment workflows. However, the effectiveness of BCT in improving communication depends on seamless interoperability between legacy systems and BCT platforms. For instance, Chang et al. (2019) emphasizes the importance of real-time tracking and automated updates in logistics, which require seamless data integration to unlock their full potential.

Traditional communication methods, such as emails and phone calls, are prone to delays and errors, particularly in manual reconciliation processes in sectors like investment banking. BCT, with its automated reconciliation capabilities via smart contracts, can replace these outdated practices, allowing organisations to focus on more strategic functions (Sandner et al., 2020; Vedapradha & Ravi, 2023). Similarly, in the construction sector, BCT and smart contracts have demonstrated effectiveness in addressing payment-related challenges by enabling secure and transparent communication (Nanayakkara et al., 2021). BCT-based platforms, as described by

Hacker et al. (2023), also enable the formation of consortia where organisations collaborate to design and manage shared systems. These consortia foster integration by building trust and sharing resources while supporting information system (IS) integration for seamless electronic exchanges. This dual integration improves both communication and collaboration among participating entities.

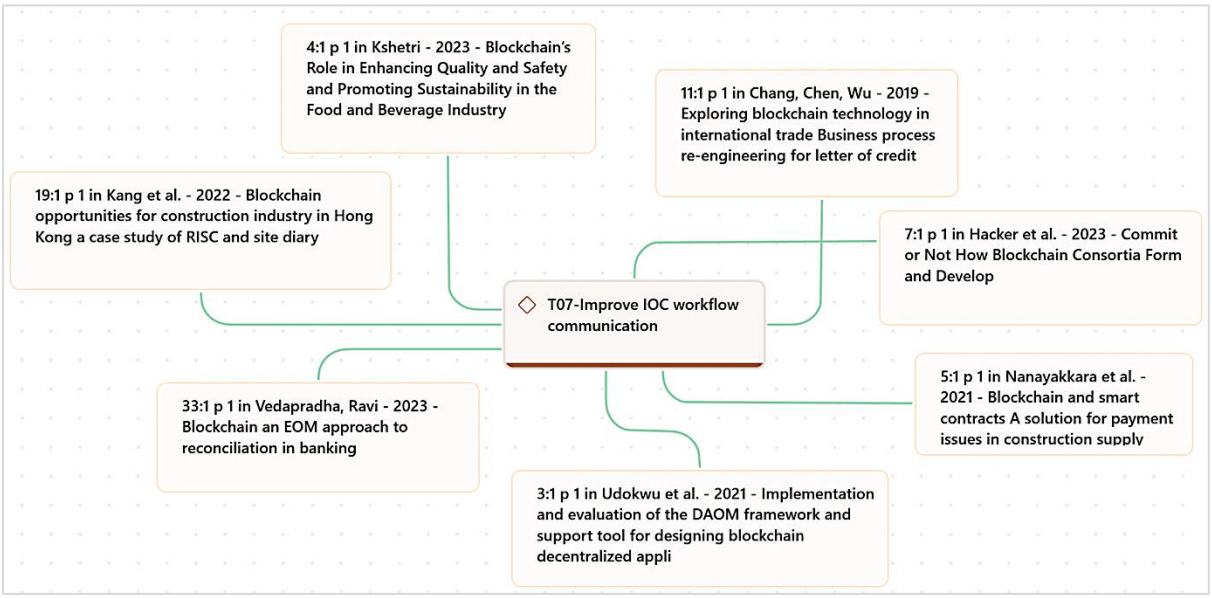


Figure 12: T07-Improve IOC workflow communication

Additionally, BCT can strengthen inter-organisational governance by reducing uncertainties and fostering equitable collaboration among stakeholders (Kshetri, 2023). By facilitating transparent and secure data exchange, BCT minimizes communication asymmetries, resulting in more balanced and efficient workflows. This aligns with the goals of the Malaysian public sector, where enhanced communication in e-payment workflows is vital for operational success. In summary, while BCT has significant potential to improve IOC workflow communication, its success depends on strategic integration with existing systems and the establishment of strong governance frameworks. These measures will ensure that Malaysian public sector agencies can effectively leverage BCT to achieve more transparent and efficient e-payment processes.

DISCUSSION

The adoption of BCT holds significant promise for enhancing IOC workflows in the Malaysian public sector. BCT's inherent features support the automation of compliance mechanisms, improving transparency and optimising financial operations. However, several challenges impede its widespread implementation, including interoperability constraints, regulatory uncertainties, difficulties in integrating legacy systems, scalability limitations and workforce readiness. Addressing these challenges is therefore essential to ensure the successful integration of BCT solutions into the operational systems of Malaysian public sector agencies.

The fundamental principles of BCT is inclusivity, whereby stakeholders such as the public sector agencies, accounting offices and acquiring banks can participate in the BCT network (Ietto et al., 2023 and Shahaab et al., 2023). This participation allows all parties to access same data and information throughout the operational process (Yassin et al., 2023). According to Dowelani et al. (2023), the integration of BCT into the IOC workflow enhances the monitoring of fund transfers within the settlement process at South African Stock Exchanges. BCT facilitates real-time information sharing among all participants and enables the automated computation of

penalties for discrepancies, thereby improving transparency and efficiency. Hence, consensus among all parties within the BCT network should be viewed as an opportunity rather than a constraint, as BCT has the potential to streamline the traditional IOC workflow in the e-payment process. For instance, integrating BCT into the e-payment system allows for real-time monitoring of fund transfers between the acquiring bank and the Malaysian public sector agency--transactions that were previously conducted in silos due to the inherently fragmented nature of the process.

Nevertheless, one of the most significant obstacles to BCT adoption is the integration of BCT with existing legacy operation system used by the participant (Jayasuriya & Sims, 2023). Many organisation continue to rely on centralised databases and traditional enterprise resource planning (ERP) systems, making the transition to a decentralised ledger environment both complex and resource-intensive (Saadan et al., 2024). The incompatibility between BCT networks and legacy systems can lead to disruptions in IOC workflow efficiency, creating operational bottlenecks that hinder the intended benefits of BCT adoption (Bible et al., 2017). Thus, a strategic, phased adoption approach is essential to overcoming these integration challenges. A recommended approach includes initiating BCT adoption through pilot projects in non-critical government functions, such as data-reconcililation task between public sector agency, acquiring bank and accounting office. Hybrid integration models, wherein BCT-based smart contracts function alongside centralised ERP systems, can provide a gradual transition without interrupting current operation process (Roszkowska, 2021). For instance, the success of the Spunta Banca DLT Project in Italy provides a valuable reference for Malaysia's public sector BCT adoption strategy. This initiative implemented BCT-based interbank reconciliation using a phased integration approach, ensuring regulatory compliance while reducing settlement times and reconciliation errors (Spahiu et al., 2024). Therefore, a similar approach could be employed in Malaysia to improve IOC workflow in e-payment process across government agencies.

Next, the scalability presents another major challenge in BCT implementation, particularly in high-volume transaction environments (Boner et al., 2023). Traditional BCT networks, such as Bitcoin, can process only seven transactions per second, whereas centralised payment networks such as Visa handle an average of 1700 transactions per second (Sharma et al., 2024). This disparity in transaction throughput limits BCT's ability to support large-scale public sector financial operations without incurring significant processing delays (Tsai et al., 2020). For instance, government agencies such as the Transport License Department of Malaysia process high volume of transactions daily, where any delays in the operational system is unacceptable. Therefore, to mitigate scalability limitations, the adoption of Layer 2 scaling solutions, such as state channels, sidechains and sharding mechanisms, is recommended. These technologies reduce computational loads on primary BCT networks by offloading certain transactions to secondary layers, significantly enhancing processing speeds (Mohammed et al., 2023).

Furthermore, regulatory uncertainty remains a major concern for new adopters of BCT, particularly concerning the legal recognition of smart contracts, compliance with financial regulations and adherence to data privacy laws (Zainutdinova, 2021). The absence of explicit regulatory frameworks governing BCT-based transactions has raised concerns about data security, liability in contract execution and the enforceability of BCT-driven agreements (Drummer & Neumann, 2020). In the Malaysian context, the adoption of regulatory sandbox initiatives, similar to those implemented by Bank Negara Malaysia (BNM) and the Securities Commission Malaysia for fintech innovations, could provide a controlled environment for testing BCT-based financial operations (Dwivedi et al., 2022). These initiatives enable policymakers to evaluate the effectiveness of BCT applications while addressing legal ambiguities and compliance risks. Consequently, the integration of private-permissioned BCT, which restrict access to verified participants, can serve as a compliance-friendly alternative to public BCT networks. Unlike fully decentralised ledgers, permissioned BCT allows for selective transparency, thereby mitigating data privacy concerns while maintaining auditability and accountability (Arjun & Suprabha, 2020). A hybrid blockchain model, which combines features of both private and public blockchains, may

offer a a balanced approach, thus ensuring data security while leveraging blockchain's transparency and immutability.

In a nutshell, while BCT offers substantial benefits in improving transparency, efficiency and automation within the Malaysian public sector, several challenges must be addressed to ensure successful implementation. Interoperability concerns can be mitigated through the use of middleware and standardised BCT protocols, while regulatory uncertainties necessitate the development of compliance frameworks and the adoption of regulatory sandbox testing. Integrating BCT with existing IT infrastructure requires a phased approach and scalability limitations may be addressed using Layer 2 scaling solutions and consortium-based BCT models. By aligning BCT implementation with Malaysia's regulatory and operational requirements, public sector agencies can fully harness its potential to strengthen governance, financial accountability and inter-agency collaboration.

CONCLUSION

In conclusion, BCT presents substantial potential for enhancing IOC workflows within the e-payment processes of the Malaysian public sector. The themes explored—automation of manual tasks, SLA monitoring, reduction of operational complexity and improved communication—highlight BCT's capacity to address critical inefficiencies. Specifically, BCT facilitates the automation of repetitive operations, real-time SLA enforcement and efficient reconciliation processes, thereby improving transaction accuracy, traceability and overall operational performance. Furthermore, BCT promotes better communication and collaboration among stakeholders, mitigating issues arising from fragmented systems. However, several challenges persist. These include interoperability issues between legacy systems and BCT platforms, legal complexities surrounding the enforceability of smart contracts and institutional resistance to decentralisation due to the regulatory nature of public sector operations. Such challenges underscore the need for robust governance frameworks and comprehensive integration strategies to align BCT within existing legal and operational structures. Technical concerns, such as scalability and transaction throughput, also present barriers to the implementation of BCT in high-volume transactional environments. To address these limitations, future research should focus on developing interoperable frameworks that facilitate seamless integration of BCT with existing systems. Additionaly, a deeper examination of legal and regulatory considerations surrounding smart contracts in the Malaysian context is essential. Investigating hybrid blockchain models that balance decentralisation with the regulatory compliance could offer practical pathways for adoption. Finaly, empirical studies assessing the long-term impact of BCT on IOC workflows in e-payment systems would provide valuable insights into its effectiveness and sustainability, informing both policy development and implementation practices.

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Appendix 1

E-payment process flow for government agency in Malaysia