

A Thematic Review on Blockchain Suitability in Inter-Organisational Collaboration Workflow In E-Payment Process in the Malaysian Public Sector

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Blockchain Technology (BCT) has emerged as a transformative tool for enhancing inter-organisational collaboration (IOC) workflows, particularly in complex, multi-stakeholder environments such as the public sector's electronic payment (e-payment) systems. In Malaysia, e-payment processes are a critical component of the government's digital transformation agenda, as outlined in the MYDigital blueprint. However, significant challenges persist in managing IOC workflows, with fragmented operational systems and reliance on manual processes undermining the efficiency and reliability of transactions among government agencies, acquiring banks, and the accounting office. The 2022 Auditor General's Report highlighted systemic inefficiencies, revealing that acquiring banks and collection agents frequently failed to meet service provision timelines, leading to delays in transferring over RM6.0 billion in government-collected funds between 2015 and 2020. These delays underscore the limitations of the current system, including service discrepancies, operational complexity, and inadequate communication. Given BCT's inherent features—transparency, decentralisation, immutability, and automation—it offers a promising solution to these persistent issues. This study aims to (i) identify trends and statistics in BCT-related research within the construction industry from 2017 to 2024 and (ii) evaluate key topics within BCT literature relevant to IOC workflows. Using a systematic search and screening process across major databases (Scopus and Mendeley), 35 eligible articles were selected for analysis. A thematic analysis, conducted with ATLAS.ti 24, identified seven critical themes: autonomous penalties enforcement, middleware for fragmented systems, automation of manual processes, SLA monitoring platforms, legality of smart contracts, reduction of operational complexity, and improvement of IOC workflow communication. The findings offer valuable insights into BCT's suitability for addressing IOC workflow challenges and highlight potential avenues for future research. These insights are expected to guide public sector organisations in accelerating the adoption of BCT as a solution for improving e-payment processes and enhancing overall operational efficiency.

1. Introduction

Blockchain Technology (BCT) has emerged as a transformative tool for enhancing inter-organisational collaboration (IOC) workflows [1], particularly in complex, multi-stakeholder environments such as the public sector's electronic payment (e-payment) systems. In Malaysia, e-payment processes form a crucial component of the government's digital transformation initiatives, as outlined in the MYDigital blueprint [2]. However, despite these advancements,

significant challenges remain in managing IOC workflows. Fragmented operational systems and a reliance on manual processes continue to undermine the efficiency and reliability of transactions between government agencies, acquiring banks, and the accounting office. The 2022 Auditor General's report identified critical inefficiencies, highlighting failures by acquiring banks and collection agents to meet service provision timelines for transferring e-payment fund collections [3]. This report further revealed that over RM6.0 billion in government-collected funds between 2015 and 2020 were delayed in reaching the accounting office. These delays underscore the limitations of the current system, which lacks effective integration across organisations, resulting in service discrepancies, operational complexities, and inadequate communication.

To address these challenges, various emerging technologies have been introduced, offering distinct advantages in enhancing information sharing, operational efficiency, and decision-making across organisational boundaries [4]. For instance, Artificial Intelligence (AI) and data analytics are revolutionising inter-organisational interactions by providing real-time insights and predictive capabilities, thus enabling more informed decision-making and fostering stronger interdependencies between organisations [5]. Similarly, advanced information technologies such as Big Data enhance IOC workflows by delivering real-time data transparency and facilitating greater automation of inter-organisational routines process [6]. However, BCT stands out due to its unique characteristics, including a decentralised, tamper-resistant ledger that ensures transparency, trust, and security [7]. Through the use of smart contracts and real-time data sharing, BCT enables the automatic enforcement of agreements and fosters accountability among multiple parties, making it particularly suited to complex, multi-stakeholder environments [8]. Thus, BCT presents a promising solution for addressing the specific challenges associated with IOC workflows in the e-payment process.

BCT can be defined as a decentralised ledger technology that records transactions in a shared network without requiring intermediary or third-party verification [9]. Technically, BCT is a decentralised ledger that organises transactions into chronologically ordered blocks, which are then distributed across multiple nodes (participants in the BCT network) to ensure traceability [10]. Unlike conventional, centralised databases, BCT is inherently decentralised, distributed, and immutable [11]. This distinguishes BCT from traditional database systems, which typically concentrate control within a single entity, such as financial institutions [1]. Instead of relying on centralised processing to validate information integrity, BCT distributes authority across a network of untrusted users.

Implementing technological solutions and process automation to address IOC workflow challenges holds significant potential for improving the e-payment process within Malaysia's public sector. However, such implementation requires a robust and intelligent system like BCT to effectively manage the complexities of IOC workflows [12]. In the Malaysian public sector, there remains a considerable gap in fully adopting BCT, primarily due to the lack of established guidelines and reference use cases for stakeholders. Accordingly, this paper seeks to explore the potential application of BCT in IOC workflows for e-payment processes. The primary objective is to identify viable solutions for enhancing existing e-payment processes through BCT. To the authors' knowledge, no prior research has examined the relationship between BCT capabilities and the e-payment process in Malaysia's public sector. This study adopts a thematic approach to ensure a comprehensive review, focusing on (i) identifying trends and statistics in BCT-related research within the construction industry from 2017 to 2024, and (ii) evaluating topics within the BCT literature relevant to IOC workflows.

2. Methodology

This study employed a non-systematic review approach, which differs from systematic reviews as it focuses on exploring the literature to gain insights into a specific issue rather than evaluating the outcomes of previous research. This method allows researchers to save time in reading and summarizing content. The approach aligns with the concept of a thematic review (TR), as introduced by Zairul [13–16], which applies thematic analysis techniques to literature reviews. According to Braun and Clarke [17], thematic analysis involves identifying patterns and developing themes through an in-depth review of the literature. Furthermore, patterns are categorized to understand trends, particularly regarding the suitability of BCT application in improving IOC workflow in e-payment process. The objective of the study is to analyze and interpret data to identify emerging trends in the BCT application in the context of IOC workflow in e-payment process. Literature selection adhered to specific criteria: (1) publications from 2017–2024, (2) sources from the SCOPUS and Mendeley databases, and (3) the use of keywords as depicts in Table 1.

Table 1 : Databases’ search terms.

Database	Selection based on strings criteria	Results
SCOPUS	TITLE-ABS-KEY ("Blockchain*" OR "BCT*" AND "Interorgani*" 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

The process of creating a thematic review paper (TR) can be divided into two distinct phases: (1) quantitative and (2) qualitative. The rigorous 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 organizations 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.

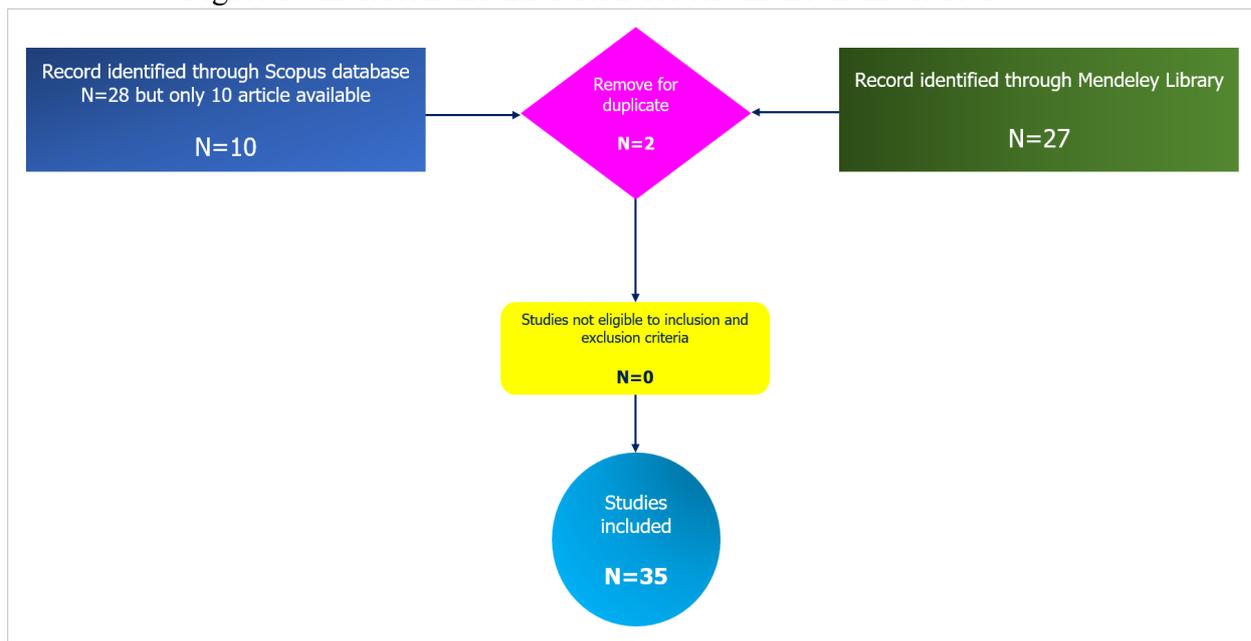
3	Article filtering	Inclusion and exclusion criteria are used in study selection. These criteria are based on the research question and aim of the study as well as fresh knowledge gained by reading the papers.
4	Cleaning and finalizing selected articles	The metadata of the articles will be double-checked 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.

The article selection is based on the inclusion and exclusion criteria mentioned earlier, as illustrated in Figure 1. The data collection process was conducted iteratively to ensure consistent outcomes at the time of writing. Mendeley was selected for its interdisciplinary scope and extensive source availability, while Scopus was selected for its comprehensive repository of peer-reviewed papers. Filters were applied to focus on article types, field area, language and open sources availability. Search criteria incorporating Boolean operators (*) were applied to the Title, Keywords, and Abstract fields, using terms such as Blockchain, Inter-organization, Relation, and Collaboration. This approach was designed to broaden and enrich the search parameters, ensuring comprehensive coverage of relevant literature. Then, the selected articles were uploaded to Mendeley for data processing, which included removing duplicates, standardizing author names, and ensuring metadata accuracy. Subsequently, 35 articles were exported to ATLAS.ti 24 for analysis to address two research questions (RQ): -

- a) RQ1: What are the patterns and statistics in BCT application on IOC workflow in e-payment process particularly in terms of articles, geographical dissemination, and thematic development in literature from 2017 to 2024?
- b) RQ2: What themes emerge from the body of literature on BCT application on IOC workflow in e-payment process?

The analysis extracted details such as article titles, publication years, authors, authors' countries, journals, keywords, and thematic areas. The study's findings are categorized into two sections: quantitative and qualitative. The quantitative analysis focuses on numerical data represented through graphs, tables, and statistics, while the qualitative analysis identifies and develops themes from the selected articles. The review provides insights into BCT suitability in improving IOC workflow in e-payment process highlighting key trends and offering a foundation for future research directions.

Figure 1 : Inclusion and Exclusion Criteria in the thematic review.



3. Results and Discussion

The reviewed studies reveal thematic trends in BCT as a tool for addressing IOC workflow challenges, particularly in financial processes. Most of studies emphasize BCT's ability to streamline reconciliation, clearing, and settlement operations while improving IOC workflow for inter-entities operation. In addition, blockchain-enabled smart contracts have been explored for their potential to automate workflows, improve data transparency, and strengthen accountability in various contexts [18]. These findings suggest that BCT fosters more efficient, secure, and transparent workflows, especially in back-end processes that often involve multiple stakeholders and complex interactions. The application of BCT in financial ecosystems highlights its ability to enhance IOC workflows by enabling trust, real-time data sharing, and process automation. Specific studies emphasize its use in monitoring service-level agreements, building collaborative platforms, and provisioning penalty-aware services.

BCT's ability to improve data control and transparency positions it as a suitable solution for resolving inefficiencies and enhancing trust in e-payment processes. This thematic analysis provides valuable insights into how blockchain can mitigate challenges related to fragmented systems, operational complexities, and manual reconciliation processes in inter-organizational financial workflows. Our review and findings have contributed to the extant literature by offering insights into several aspects of the implementation of BCT in improving IOC workflow in e-payment process. Thus, the important results of the thematic review are summarized in this section. The quantitative part at the beginning of this section will support the qualitative reporting for thematic evaluation. The first RQ will be addressed in the quantitative section, while the second will be addressed in the qualitative section.

3.1 Quantitative findings

The study trends considered the year of publication, industrial context, research focus, and thematic subject, reflecting patterns similar to those observed in the BCT application in financial domain, thereby addressing RQ1. Figure 2 depicts a notable increase in the number of relevant articles was observed from 2021 to 2024, with a significant peak in 2023. However, a decline was recorded in 2024, which can be partially attributed to the review being conducted early in that year, potentially limiting the inclusion of more recent publications. This pattern underscores the growing interest in the application of advanced technologies during this period.

Figure 2 : A breakdown of articles by year of publication.

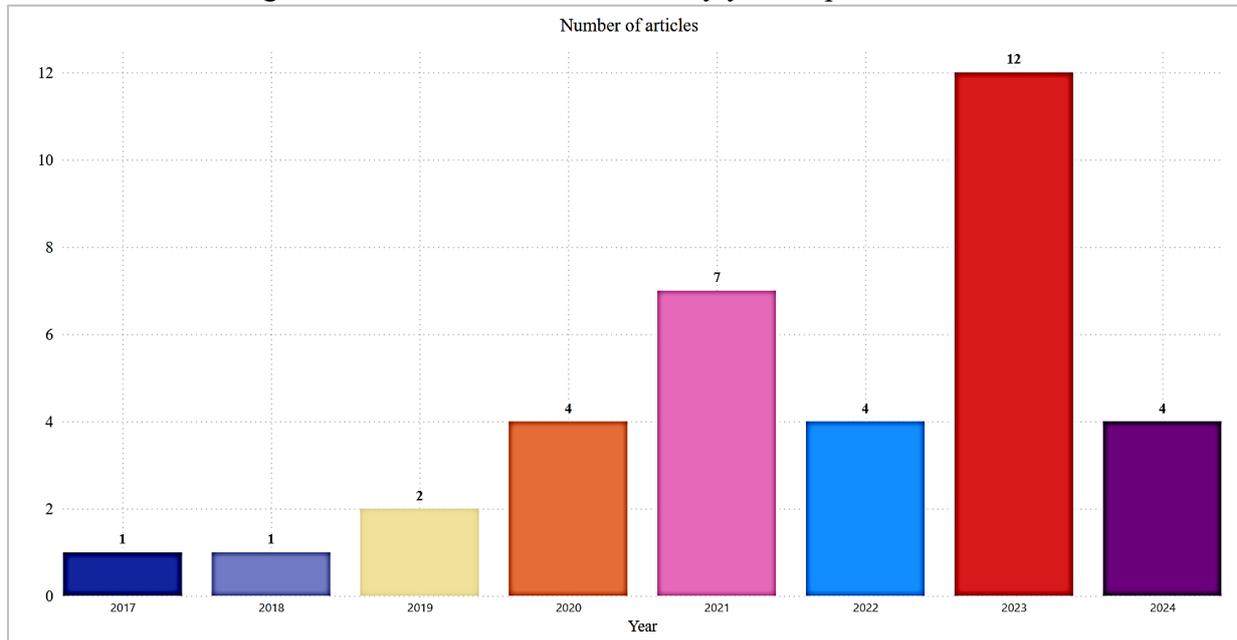


Figure 3 illustrates the publication trends across various countries illustrate the increasing focus on BCT as a means to enhance inter-organizational workflows (IOCs) across diverse sectors. Developed economies such as the United States, Germany, and Italy have been at the forefront of exploring BCT’s potential to address inefficiencies in financial systems, supply chains, and smart contract applications. For instance, studies in the United States have examined BCT’s role in improving financial service operations and enhancing quality and safety standards in supply chain collaborations, showcasing its capability to streamline data-sharing processes and promote trust between stakeholders. Similarly, Germany has produced significant work on BCT’s integration into international trade and smart contract enforcement, addressing longstanding issues of fragmented operations and limited transparency in inter-organizational engagements. Italy’s contributions often focus on financial and supply chain domains, with research exploring BCT’s use in collaborative platforms and fraud mitigation in accounting systems, reinforcing its potential to resolve coordination challenges across organizational boundaries.

Emerging economies have also made notable contributions, particularly in areas where existing IOC workflows are characterised by inefficiencies and lack of trust. In India, for example, studies have centred on BCT’s applications in government operations and banking reconciliation, aiming to improve inter-agency collaboration and data control. Similarly, research from Bangladesh highlights the regulatory challenges of BCT adoption in financial reporting, underscoring the importance of transparent data exchange in mitigating fraud risks. In Morocco,

the integration of BCT in healthcare IOC workflows has been examined, especially in the context of managing large-scale processes such as those necessitated by the COVID-19 pandemic. These studies from developing regions highlight the technology's adaptability to address unique inter-organizational challenges, such as fragmented communication channels and inconsistent service-level agreements (SLAs).

Figure 3 : Geographical dispersion on the article published.



In Malaysia, research reflects a growing recognition of BCT's utility in improving IOC workflows within critical sectors. For example, studies have explored its applications in freight booking and banking reconciliation, highlighting how BCT's attributes—such as distributed ledger technology and automated contract execution—can alleviate operational inefficiencies, strengthen trust, and enhance coordination between parties. These insights align with Malaysia's focus on modernising workflows across sectors such as transportation, finance, and public administration, where inter-organizational collaboration is vital. Specifically, BCT is seen as a solution to address coordination challenges, improve transparency, and facilitate seamless data-sharing between stakeholders such as government agencies, financial institutions, and private enterprises.

Overall, the literature from both developed and emerging economies underscores the global relevance of BCT in transforming IOC workflows. While advanced economies tend to focus on leveraging BCT for innovation in established systems, developing regions highlight its potential to resolve foundational inefficiencies in inter-organizational processes. The Malaysian perspective contributes to this discourse by demonstrating the practical applicability of BCT in addressing specific operational gaps, particularly in areas where collaboration between multiple organizations is crucial for workflow optimisation. This convergence of global and regional studies further solidifies BCT's role as a transformative enabler of efficient, transparent, and trust-driven IOC workflows.

Next, Table 3 illustrate the themes emerging from this study can be categorized as follows: T01: Autonomous penalties enforcement, which reflects the potential of BCT to enable self-executing mechanisms for compliance; T02: Middleware for fragmented systems, addressing the integration challenges across diverse systems; T03: Automation of manual processes, emphasizing

the reduction of inefficiencies in current workflows; T04: SLA monitoring platform, focusing on enhancing accountability and ensuring compliance with agreements; T05: Legality of smart contracts, which highlights concerns regarding enforceability and trust in automated agreements; T06: Reduction of operational complexity, showcasing the streamlining of processes to improve workflow efficiency; and T07: Improved IOC workflow communication, illustrating how BCT fosters better data exchange and collaboration among stakeholders. These themes collectively demonstrate the potential of BCT in addressing various inter-organizational workflow challenges.

Table 3 : Author vs. Themes

No	Authors	Theme code (*)						
		T01	T02	T03	T04	T05	T06	T07
1	Bosco et al.[19]					/		
2	Spahiu et al. [1]						/	
3	Akter et al. [20]					/	/	
4	Sharma et al.[21]						/	
5	Jahagirdar [22]	/						
6	Nguyen et al. [23]	/						
7	Odunlami and Samuel [24]		/					
8	Chowdhury et al. [25]			/				
9	Kumar et al. [26]			/				
10	Vedapradha and Ravi [27]			/				/
11	Hacker et al. [28]							/
12	Khelifi et al.[29]				/			
13	Sabri et al. [30]				/			
14	Dowelani et al. [31]						/	
15	Kshetri [32]							/
16	Du et al. [33]				/			
17	Rachad et al.[18]	/						
18	Centobelli et al. [34]			/				
19	Kang et al. [35]							/
20	Dwivedi et al. [36]					/		
21	Albert and Sundarakani [37]		/					
22	Roszkowska [38]		/					
23	Udokwu et al. [39]							/
24	Weerakoon and Chandanie [40]						/	
25	Kassmi and Jarir [41]				/			
26	Nanayakkara et al. [42]							/
27	Zainutdinova [43]					/		
28	Nikbakht et al. [44]			/			/	
29	Tsai et al. [45]		/					
30	Sandner et al. [46]		/					
31	Drummer and Neumann [47]					/		
32	Chiu and Koepl [48]		/					
33	Chang et al. [49]							/
34	Neidhardt [50]				/			
35	Treleaven et al. [51]			/				

(*) 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 various fields. In Accounting and Finance, journals such as International Journal of Accounting Information Systems focus on improving financial processes and fraud prevention. Information Systems and Technology journals like Journal of Information Technology explore blockchain’s role in data security and smart contracts. Management and Business publications, including California Management Review, examine blockchain’s impact on operations and supply chains. Law and Compliance research addresses regulatory challenges, while Engineering and Construction studies, such as those in Construction Innovation, emphasize payment and project management improvements. Finally, General Science journals like Administrative Sciences provide broader insights into blockchain’s organizational and technological impacts.

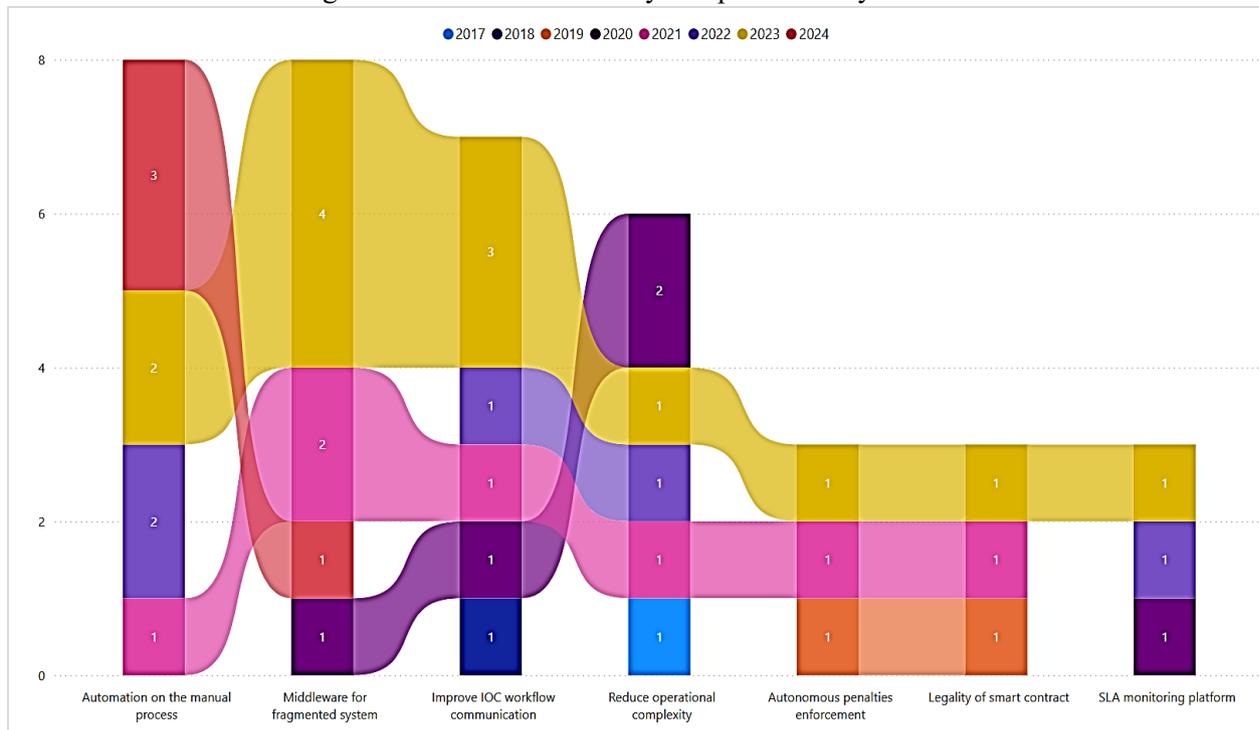
Table 4 : Periodical vs. year of publications

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

Publications	2024	2023	2022	2021	2020	2019	2018	2017	Total
Proceedings - 2022 9th International Conference on Wireless Networks and Mobile Communications			1						1
Journal of Accounting and Organizational Change				1					1
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 BCT application in IOC workflow in e-payment process. These trends align associates with the broader challenges faced by the organisation on IOC workflow process in e-payment domain. While, this study also discusses the suitability of BCT is resolving the IOC workflow in e-payment process (see Figure 4)

Figure 4 : Themes of the study and publication years.

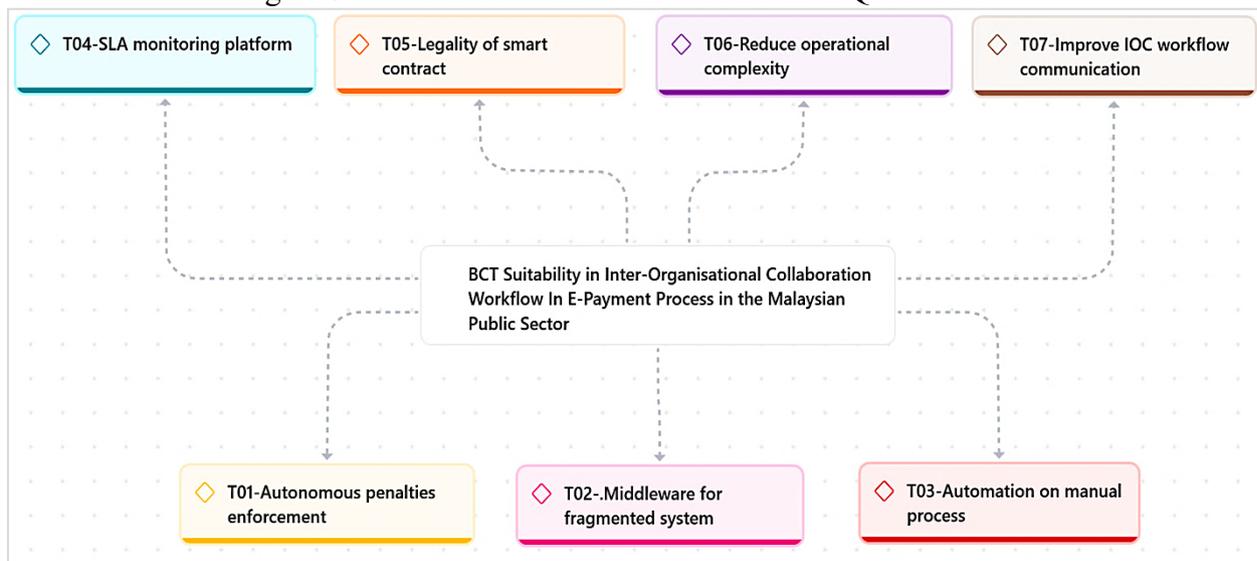


3.2 Qualitative findings

This TR paper reviewed publications and coded the patterns in the BCT in IOC workflow.

However, it did not address the specific solution on e-payment process by embedding BCT in IOC workflow. In multiple rounds of process, the initial codes were recorded, combined, and categorized. Codes that were seldom used and could not be categorized into any topic were removed since this study was concerned with aspects that had been extensively discussed and investigated by researchers. Results from quantitative investigations that were not statistically significant were also removed. Furthermore, generic sociodemographic characteristics were not considered because they may not be universally applicable to all circumstances. Finally, seven major themes emerged: 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. Each theme is investigated in further detail below, and results outside of the themes or the evaluated articles will be referenced as needed for descriptive reasons (Figure 5)

Figure 5 : Overall network to answer Research Question 2



T01-Autonomous penalties enforcement

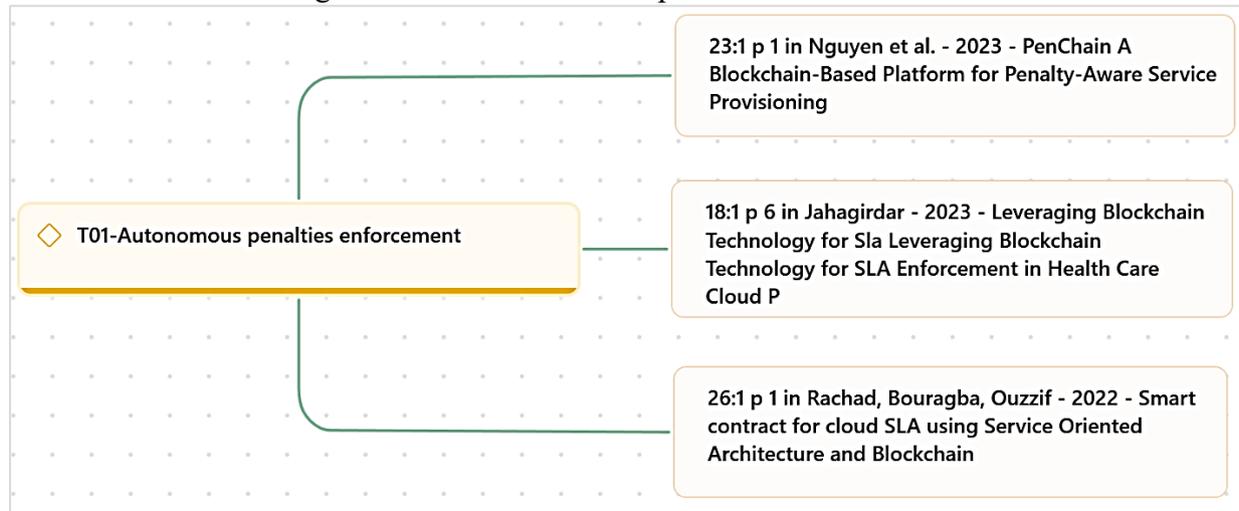
The use of BCT to enhance IOC workflows, particularly in the enforcement of service-level agreements (SLAs), is gaining significant traction across various industries (see Figure 6). The research by Nguyen [23] introduces PenChain, a blockchain-based platform designed for SLA-minded service provisioning. By leveraging BCT, PenChain automates SLA enforcement using machine-readable logic, ensuring penalties are programmatically enforced when service commitments are not met. Evaluations in fields such as precision agriculture and automotive manufacturing demonstrate the platform’s scalability, transparency, and effectiveness in ensuring service quality. Rachad’s [18] work similarly explores the application of BCT in automating SLA execution, specifically within cloud computing systems for healthcare SMEs. By integrating smart contracts, BCT enhances real-time data transparency and accountability, reducing fraud and errors while decentralising trust. The study highlights key implementation challenges such as regulatory uncertainty, interoperability, and privacy concerns, recommending further research to optimise BCT integration in diverse organisational contexts.

Jahagirdar [22] focuses on healthcare cloud partnerships, addressing challenges in SLA enforcement due to limited resources and technical expertise in SMEs. The study demonstrates how BCT-based smart contracts improve SLA management by automating compliance, ensuring

data integrity, and fostering stakeholder trust. Findings emphasise the potential of BCT to enhance operational scalability and accountability, despite persistent issues related to governance, cost, and user adoption.

These studies collectively illustrate BCT's suitability for addressing SLA enforcement challenges in multi-stakeholder environments. The autonomous penalty enforcement enabled by BCT not only strengthens compliance mechanisms but also enhances trust and efficiency in IOC workflows. This theme is particularly relevant for improving the IOC workflow in e-payment process at the Malaysian public sector, where similar challenges of negligent finding from the Auditor General of Malaysia.

Figure 6 : T01-Autonomous penalties enforcement



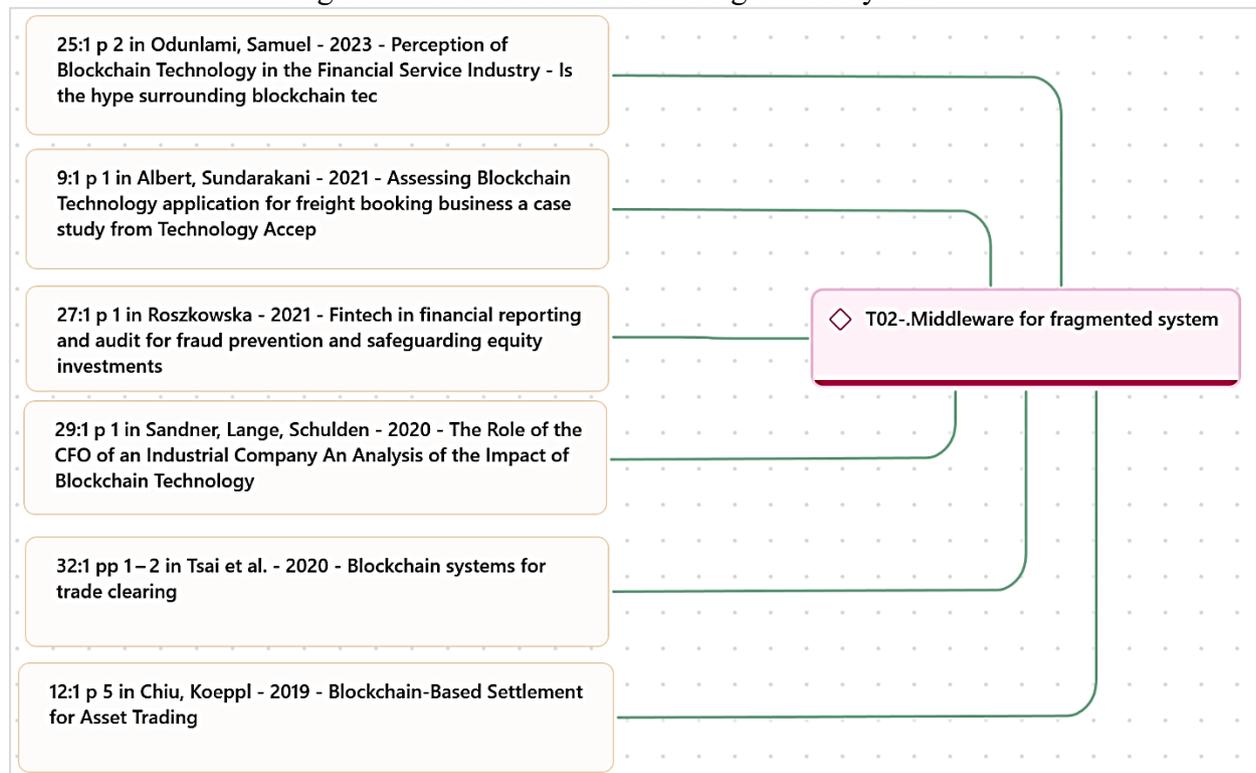
T02-Middleware for fragmented system

A fragmented system results in siloed operations, where organisations function independently, hindering the efficiency and fluidity of IOC workflow. In such environments, communication and data exchange become cumbersome, leading to delays, errors, and operational inefficiencies [52]. In enterprise resource planning (ERP) ecosystems, BCT has proven effective in enhancing process efficiency by standardising and aggregating data [53]. This enables more informed decision-making for strategic roles, such as Chief Financial Officers [46]. The case of the Guangdong Clearing House (GCH) further illustrates how BCT allows participants to maintain their independent databases while securely sharing data across the network, fostering collaboration without compromising data sovereignty [45]. By decentralising data-sharing processes and automating critical functions, BCT eliminates the need for centralised post-trade infrastructure, often associated with manual reconciliation and resource-intensive tasks [48]. Therefore, BCT offers significant potential for streamlining IOC workflows in the e-payment process for Malaysian public sector agencies, where fragmented systems create operational bottlenecks. Automation and standardisation through BCT could mitigate these fragmentation risks, enabling more seamless and transparent e-payment processes (see Figure 7).

However, challenges related to standardisation and interoperability remain significant barriers to BCT implementation [24]. For instance, in accounting, large-scale data processing necessitates full system interoperability to support high-capacity data analysis [38]. Current BCT networks often operate in isolation, leading to interoperability challenges, including discrepancies in consensus models, transaction schemes, and smart contract functionalities [37]. Proposed solutions, such as the integration of Application Programming Interfaces (APIs), have been

implemented by multinational corporations like IBM, Microsoft, and GS1 to promote interoperability in BCT applications for supply chain management. Addressing these standardisation and interoperability issues is critical for unlocking BCT's full potential. This research aims to explore how BCT, functioning as middleware, can be effectively implemented within Malaysian public sector agencies' IOC workflows to overcome fragmentation challenges and enhance the e-payment process.

Figure 7 : T02-Middleware for fragmented system



T03-Automation on the manual process

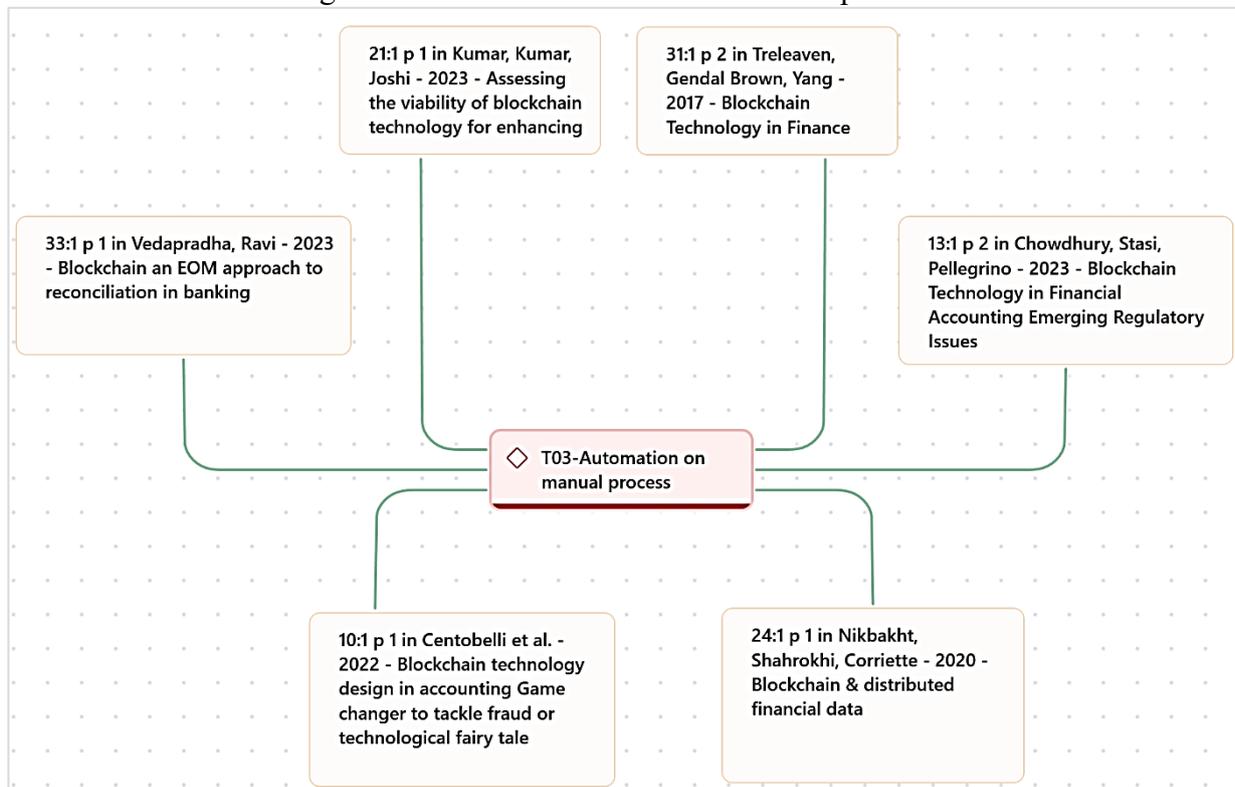
BCT offers inherent capabilities for automating fixed and routine operations, particularly in environments with manual processes. In accounting, for example, manual reconciliation can be replaced by automated processes on a BCT platform, streamlining operations and reducing human error [34]. This shift not only improves efficiency but also allows organisations to reallocate staff to more strategic roles, thereby enhancing overall productivity [25]. For Malaysian public sector agencies, automating the reconciliation of e-payment transactions is expected to significantly reduce errors and improve operational efficiency, enabling staff to focus on higher-value tasks. Such process improvements can lead to substantial cost savings for both the government and its stakeholders, contributing to a more seamless financial ecosystem [25]. These cost efficiencies are anticipated to optimise IOC workflows between agencies, acquiring banks, and accounting offices, ensuring smoother operations in the future.

Additionally, Kumar et al. [26] emphasise that smart contracts embedded within BCT reduce transaction costs and increase processing speed, as demonstrated in court case management systems. In the e-payment context, BCT enhances transparency, allowing banks to track detailed transaction information, such as type (deposit, withdrawal, wire), amount, and timestamp [44]. Implementing smart contracts within BCT can automate reconciliation processes between public

sector agencies, acquiring banks, and accounting offices. This automation will expedite fund transfers and revenue recognition, improving the accuracy and traceability of high-volume transactions. Consequently, Malaysian public sector agencies can manage complex e-payment operations more efficiently.

To fully eliminate manual processes, it is essential for all parties within a BCT network to be interconnected via APIs. Vedapradha and Ravi [27] explain that APIs facilitate seamless updates of transactions between investment banks and their counterparties, with any discrepancies automatically managed by smart contracts [51]. Effective implementation requires robust governance frameworks and clear operational guidelines to ensure proper use by employees [54]. In the Malaysian government context, governance structures are typically outlined in treasury circulars and operational guidelines. However, a key challenge lies in translating these frameworks into programming language for BCT integration. Legal approval from relevant boards, along with a strategic blueprint for the technological workflow, is crucial to ensure compliance with data regulations, streamline reporting, and uphold transparency and accuracy [55]. By aligning BCT adoption with established legal and operational standards, public sector agencies can minimise the risks of non-compliance and data inaccuracies, ensuring the successful implementation of automated processes.

Figure 8 : T03-Automation on the manual process



T04-SLA monitoring platform

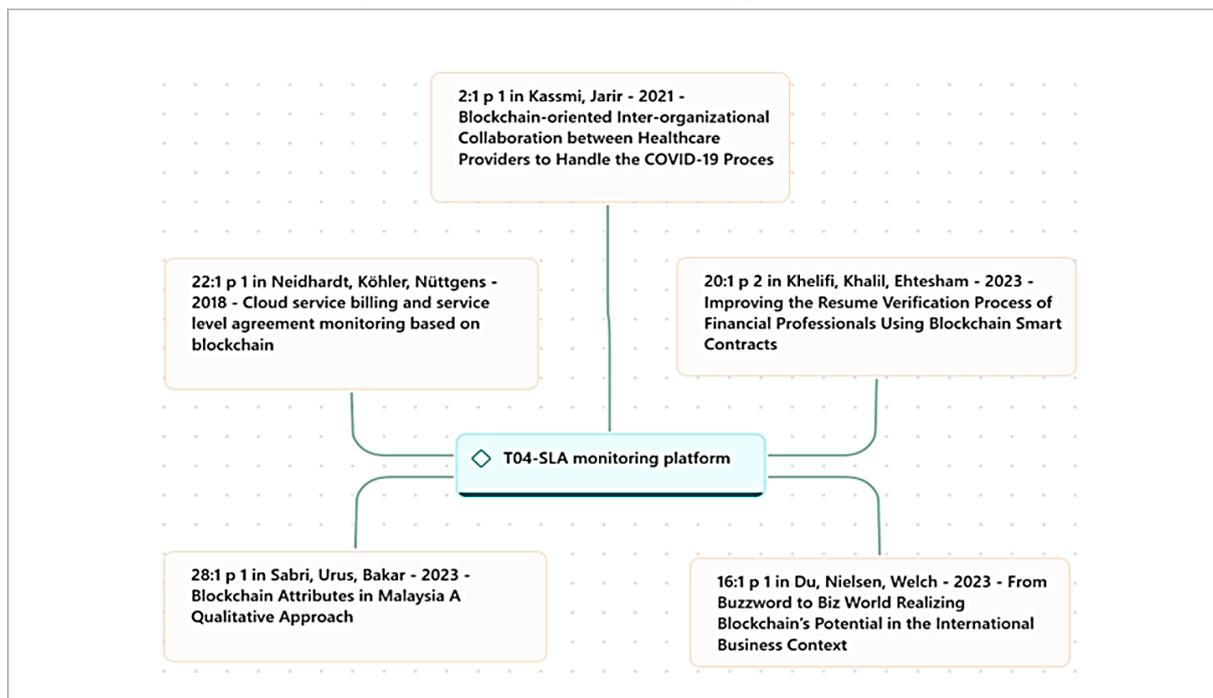
Service provision plays a crucial role in assessing the quality-of-service delivery, particularly in online transactions. Typically, SLAs formalise the terms between contracted parties, detailing the service expectations. However, these agreements have traditionally been managed manually, a process prone to delays, errors, and lapses in enforcement [29]. The 2022 Auditor General’s Report highlighted significant challenges faced by Malaysian public sector agencies in

enforcing SLA terms, particularly with acquiring banks regarding delays in fund transfers. BCT offers a transformative solution by automating SLA monitoring, thereby enhancing transparency and trust (see Figure 9). As Neidhardt et al. [50] demonstrate, real-time information sharing enabled by BCT within cloud environments improves SLA compliance. Similarly, Sabri et al. [56] report that BCT allows parent companies to monitor inter-company transactions in real-time, replacing the traditional monthly review process. Malaysian public sector agencies could leverage BCT to enable real-time monitoring of SLAs with acquiring banks and accounting offices, addressing current inefficiencies.

BCT's decentralised and tamper-proof nature enhances accountability and reduces the risk of fraud in financial operations [25]. By integrating BCT, financial reporting systems can become more efficient and transparent, which is particularly relevant for agencies seeking to improve their IOC workflows. Chowdhury's analysis underscores the need for policymakers and regulators to address challenges such as standardisation, scalability, and privacy before widespread adoption can be achieved. Similarly, Kumar [26] highlights BCT's potential in judicial systems, where it improves the efficiency of court procedures by creating immutable, transparent records. These benefits extend to SLA monitoring, where BCT can streamline the creation and enforcement of agreements, reducing manual intervention and associated transaction costs.

Further, Du [57] discusses the role of BCT in eliminating administrative costs and improving information sharing across supply chains, a feature that could benefit SLA monitoring platforms. By digitising and automating compliance data, BCT enhances transparency and facilitates seamless collaboration among stakeholders, including auditors and third-party certifiers. This capability can be adapted to the Malaysian public sector's e-payment systems, where automated SLA monitoring would ensure adherence to agreed terms, reduce delays in fund transfers, and improve overall workflow efficiency. Addressing the challenges of interoperability and governance is critical to realising these benefits. Establishing robust governance frameworks and integrating BCT with existing systems will be key to ensuring successful implementation.

Figure 9 : T04-SLA monitoring platform

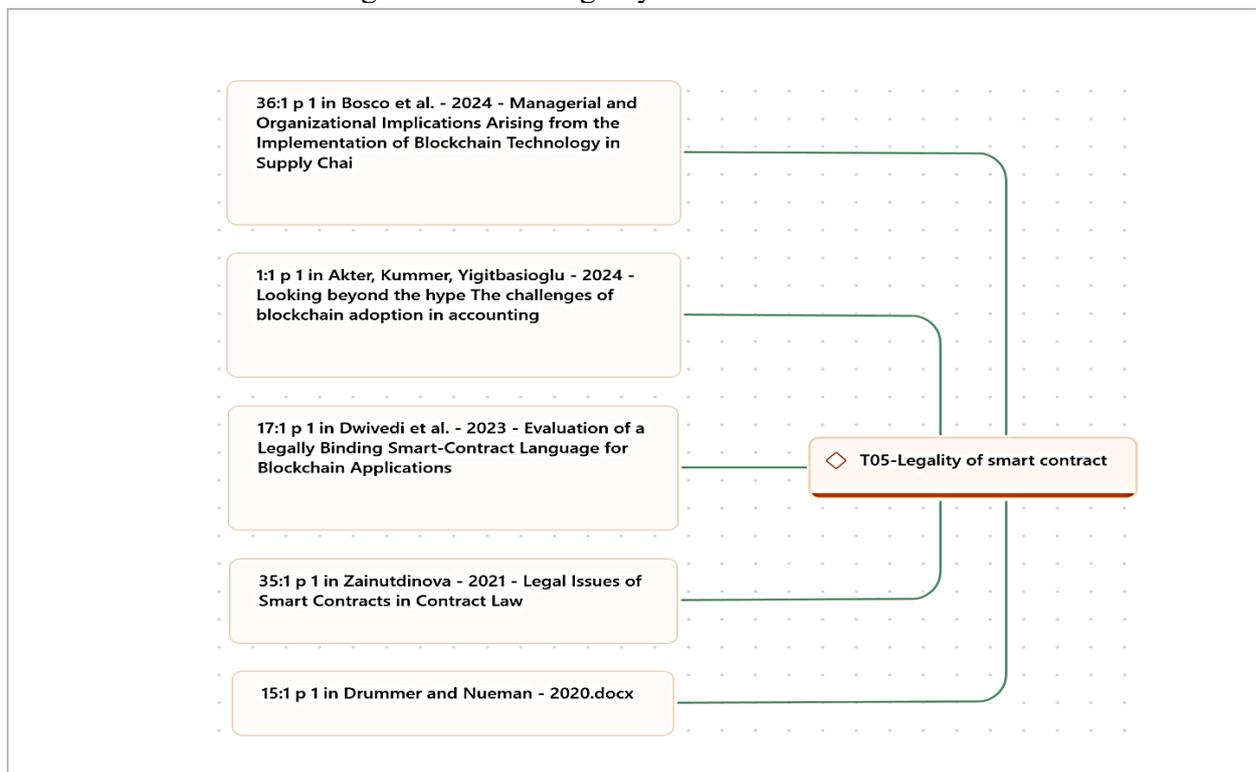


T05-Legality of smart contract

The integration of SLA terms within smart contracts, encompassing elements such as service provision, timeframes, and penalties for breaches, significantly enhances the monitoring and enforcement of IOC workflows. This functionality is particularly pertinent to the Malaysian public sector, where enforcing SLAs in back-end e-payment processes remains a critical challenge. The Ministry of Finance has emphasised the necessity for government agencies to impose penalties on acquiring banks for SLA violations. By adopting BCT, public sector agencies could enable real-time SLA monitoring, automatic enforcement of penalties, and increased accountability. This approach would improve SLA compliance while streamlining the efficiency of back-end e-payment processes, ensuring that discrepancies or delays are promptly resolved.

However, the enforceability of BCT-based smart contracts raises complex legal and regulatory challenges [47]. While smart contracts are considered legal due to their automated execution and termination mechanisms, their alignment with existing contract law remains contentious [43]. Key considerations include potential conflicts with existing laws, the technical design of smart contracts, and their suitability for widespread adoption. Dwivedi et al. [58] argue that although smart contracts are not inherently legally binding, their potential can be realised by ensuring three forms of suitability: semantic, workflow, and expressiveness. Semantic suitability involves including fundamental elements such as the parties, terms, and exchanges. Workflow suitability requires smart contracts to align with established processes, incorporating control-flow, data-flow, resource-flow, and exception-handling mechanisms. Finally, expressiveness pertains to the technical programming needed to ensure the accuracy and functionality of smart contracts.

Figure 10 : T05-Legality of smart contract



In the Malaysian government context, the concept of smart contracts is not entirely new. Applications such as ePerolehan have incorporated elements of smart contracts, though not on a

BCT platform. Embedding BCT-based smart contracts in the e-payment process would necessitate a clear understanding and acceptance by public sector officers, particularly given concerns around data privacy and confidentiality. Akter [20] highlights resistance to sharing sensitive information on public BCT networks, citing potential governance and regulatory compliance issues. This is especially relevant as privacy laws, such as the Privacy Act in many jurisdictions, impose stringent rules on data handling, which could create legal challenges for BCT implementations (see Figure 10).

Moreover, [19] underscores the ability of BCT to decentralise data flows and certify digital documents through distributed ledgers, ensuring that data is reliable, immutable, and secure. This capability enhances trust in the informational flow across supply chains, a feature that could similarly benefit financial and e-payment workflows in the Malaysian public sector. While legal and regulatory frameworks must evolve to accommodate these technologies, BCT offers a robust solution for improving the reliability and transparency of IOC workflows, provided its implementation aligns with established legal and operational standards.

T06-Reduce operational complexity

BCT offers a robust solution to reducing operational complexity through its decentralised, transparent, and immutable framework. By streamlining processes, minimising inefficiencies, and enhancing coordination among multiple organisations, BCT has demonstrated its effectiveness in high-volume transaction environments [59]. For instance, BCT has been successfully implemented in trade clearing and settlement systems, efficiently handling hundreds of thousands of transactions while addressing critical challenges such as performance, privacy, and scalability [44]. This capability could be extended to the operations of Malaysian public sector agencies, which similarly manage large transaction volumes. In a decentralised setting, processes like settlement can be automated and executed transparently, significantly reducing delays and operational inefficiencies [31].

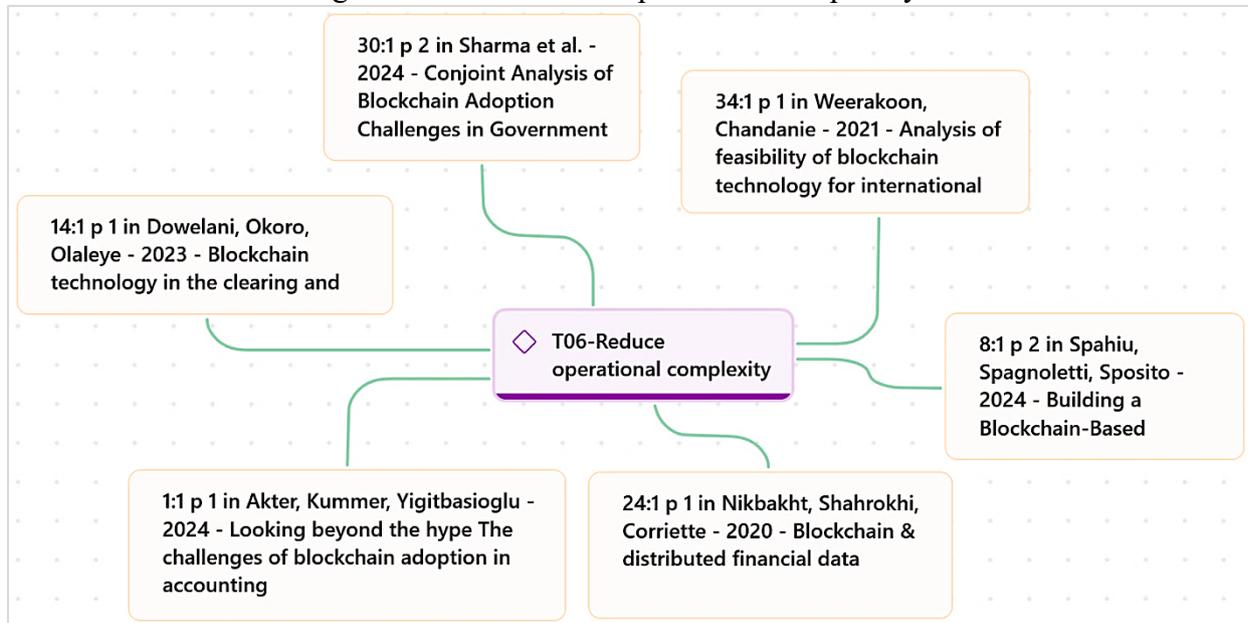
However, the highly regulated nature of public sector operations presents challenges to adopting a fully decentralised system. The removal of a central authority in such contexts is often complex and time-consuming [20]. Sharma et al. [21] highlight that government agencies frequently operate in silos due to fragmented systems, which BCT can help mitigate. Nevertheless, the reluctance to relinquish central regulatory oversight can impede BCT adoption. For instance, cross-border fund transfers still require central bank approval to validate transactions, underscoring the necessity of a central authority's role [40]. Instead of eliminating this role, BCT can complement it by establishing a hybrid system. Such a system would maintain regulatory oversight while enhancing collaboration and efficiency within a decentralised framework [60]. This approach enables Malaysian public sector agencies to achieve operational efficiency improvements without compromising essential regulatory controls.

Furthermore, as organisations increasingly adopt collaborative digital technologies, BCT has gained traction for its capacity to facilitate inter-organisational processes [1]. The Spunta Banca DLT Project in Italy exemplifies the successful deployment of a permissioned BCT solution for interbank reconciliation, highlighting the importance of integrating diverse organisational needs and adhering to decentralised governance structures. The project's success was attributed to a stepwise legitimacy-building process, encompassing pragmatic, normative, and cognitive dimensions. Such an approach could inform the Malaysian public sector's efforts to implement BCT for improving IOC workflows.

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 [21]. 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.

Figure 11 : T06-Reduce operational complexity



T07-Improve IOC workflow communication

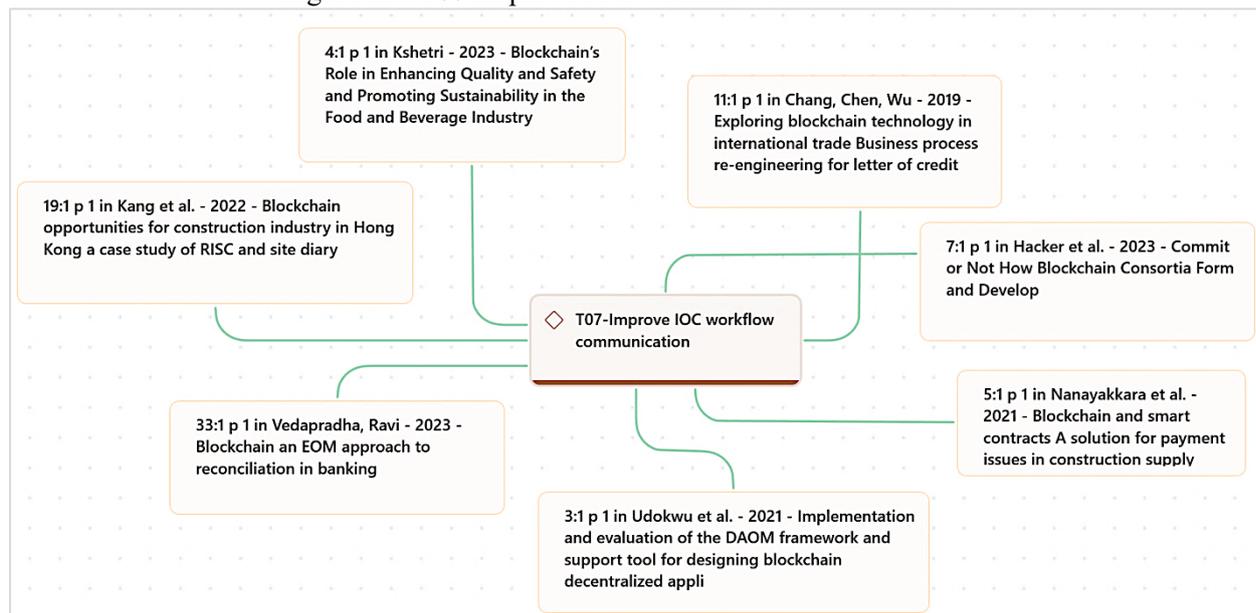
A fragmented system significantly impairs communication in IOC workflows, leading to delays, inefficiencies, and increased operational costs. Poor communication among stakeholders often results in project delays, cost overruns, and incomplete tasks [61,62]. While traditional systems are designed to coordinate supply chain operations and reduce costs [63], they often fall short in addressing the fragmentation inherent in complex back-end e-payment processes. This raises concerns about the adequacy of existing systems in managing such operations effectively. BCT has emerged as a potential solution for enhancing communication in IOC workflows. Kang et al. [35] demonstrate how BCT and smart contracts can streamline inter-organisational communication, as seen in trade finance supply chains through the automation of letters of credit. These capabilities are highly relevant to Malaysian public sector agencies, which manage diverse stakeholders, including acquiring banks and accounting offices, in their e-payment workflows. However, the success of BCT in improving communication depends on achieving full interoperability between legacy systems and BCT platforms. For instance, Chang et al. [49] highlights that real-time tracking and automated updates in logistics require seamless data integration to achieve their full potential.

Traditional communication methods, such as emails and phone calls, are prone to errors and delays, particularly in manual reconciliation processes in sectors like investment banking. BCT, with its capability for automated reconciliation via smart contracts, could replace these outdated processes, allowing organisations to focus on strategic functions [27,46]. Similarly, in the construction industry, BCT and smart contracts have been shown to mitigate payment-related issues by facilitating secure and transparent communication [42]. Moreover, BCT-based platforms, such as those described by Hacker [28], enable the creation of BCT consortia, where

organisations collaborate to design and operate shared systems. These consortia foster relational integration by establishing trust and shared resources while simultaneously enabling information system (IS) integration for seamless electronic exchanges. This dual integration enhances both communication and cooperation among participating organisations.

Furthermore, BCT can enhance inter-organisational governance by reducing uncertainty and fostering equitable collaboration among stakeholders [64]. By enabling transparent and secure data exchange, BCT reduces asymmetries in communication, offering a more balanced and efficient workflow. This aligns with the goals of the Malaysian public sector, where improved communication in e-payment processes is crucial for operational success. In conclusion, while BCT holds significant promise in enhancing IOC workflow communication, its full potential can only be realised through strategic integration with existing systems and robust governance frameworks. These steps will ensure that Malaysian public sector agencies can leverage BCT to achieve more efficient and transparent e-payment processes.

Figure 12 : T07-Improve IOC workflow communication



4. Conclusion

In conclusion, BCT offers significant potential for improving IOC workflows within the Malaysian public sector’s e-payment processes. The findings across the discussed themes—automation of manual processes, SLA monitoring, reduction of operational complexity, and enhanced communication—highlight BCT’s capacity to address key inefficiencies. Specifically, BCT facilitates the automation of routine operations, real-time SLA enforcement, and streamlined reconciliation, which collectively improve transaction accuracy, traceability, and operational efficiency. Moreover, BCT enhances communication and collaboration among stakeholders, mitigating issues caused by fragmented systems. However, the study identifies several limitations. Key challenges include interoperability between legacy systems and BCT platforms, the legal enforceability of smart contracts, and resistance to decentralisation due to the regulatory requirements of public sector operations. These limitations underscore the need for a robust governance framework and comprehensive integration strategies to align BCT with existing legal and operational standards. Additionally, scalability and transaction throughput remain technical challenges that could hinder BCT’s full implementation in high-volume environments. Given these

limitations, future research should focus on developing interoperable frameworks that facilitate seamless integration of BCT with existing systems. Further investigation into the legal and regulatory implications of smart contracts within the Malaysian context is also essential. Additionally, exploring hybrid models that balance decentralisation with necessary regulatory oversight could provide valuable insights for public sector adoption. Finally, empirical studies on BCT's long-term impact on IOC workflows in e-payment processes would offer a deeper understanding of its effectiveness and sustainability, informing both policymakers and practitioners.

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