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Key Success Factors for Integration of Blockchain and ERP Systems: A Systematic Literature Review

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Abstract

Blockchain technology offers immense potential for increasing efficiency by streamlining business operations. However, blockchain implementation is disruptive and requires high capital organizational processes as it fundamentally re-engineers and automates business processes. By integrating blockchain with Enterprise Resource Planning systems (ERPs), organizations can enjoy the benefits of blockchain adoption with minimal disruption to their business model. The resources regarding integration of blockchain systems and ERP are scarce and dispersed as their applications are in different niches. Thus, there is a need for a study of literature that investigates blockchain and ERP integration and find its key success factors. This systematic literature review (SLR) investigates the key success factors of blockchain and ERP integration and finds the context of integration to derive meaningful insights regarding its application in different functional areas. A list of key success factors is identified. They could be broadly classified into three contexts – technological, organizational, and regulatory. Also important is the environment and sustainability of the integration. This study was able to conclude that the integration of ERP systems with blockchain will enhance the capabilities of current ERP systems by providing value propositions of the decentralized ledgers such as increased transparency, trust, and process automation.

Keywords: Blockchain, ERP, Enterprise Resource Planning

1. Introduction

Enterprise Resource Planning (ERP) systems are universally used to automate and manage business processes. Integrating blockchain with ERP systems offer a very lucrative value proposition for businesses. They can leverage the merits of blockchain such as decentralization, increased transparency, and traceability, while suffering none of its disruptions. As blockchain is a very cost and time intensive investment, organizations are now looking to integrate blockchain with ERP systems cautiously to enjoy blockchain functionalities such as smart contracts and non-fungible tokens whilst also benefiting from the opportunities ERP presents. The efficiency and streamlining provided by blockchain and the possibility of data sharing and collaboration can increase synergy within the organization and cross organizational venues when integrated with ERP. It is important to understand the key success factors for the integration to increase efficiency and sustainability. This paper conducts a systematic literature review to investigate the key success factors for ERP and blockchain integration. This investigation will try to answer the following questions. (1) What are the key success factors for this integration? (2) What is the context of their integration? As the literature available that address these topics are spread across disciplines of computes science, web development, software

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engineering and business process management, this survey as one of the early studies that provide insights into the key success factors for blockchain and ERP integration. The remainder of the paper is structured as follows. Section 2 contains the background and overview of related work. Briefly highlighted are the blockchain technology, enterprise resource planning systems, and Blockchain and enterprise resource planning integration. Section 3 describes the methodology adopted in this study and the findings are presented in Section 4. Also contained in Section 4 is a discussion of the results. The paper ends in Section 5 with conclusions and recommendation for future work.

2. Background and Related Work

2.1 Blockchain Technology

Blockchain is a decentralized and distributed ledger of digital transactions. Technically, it is an immutable ledger that records the transfer of anything that is deemed to have value [1]. By using the theories of cryptography, blockchain can run an entire financial ecosystem in the virtual world. Every activity happening in the blockchain will be recorded by the ledger and published widely for all participant to see [20]. This offers transparency and traceability in the transfer and thus inculcate digital trust. By the advent of smart contracts – scripts that talks to blockchain and instructs it how to behave – blockchain has found applications in business, healthcare, auditing and accounting and several other domains [20].

2.2 *Enterprise Resource Planning system*

ERPs incorporates functional entities of an organization into a centralized platform. Envisioned to be an inventory management tool and later as a collaboration facilitator, they have now evolved to be massive information management and analytics ecosystems that is essential for running any major organization [32]. Successful implementation of ERP in an organization requires considerable investment of money, time, and other resources. Generally, ERP optimizes resource allocation in business while promoting integration of cross-system functions and collaboration of cross-organizational departments across different geographical departments [33]. Technologically, they are an online transaction processing system with real-time response and integrated functionality [33]. Leveraging information technology tools, they help organizations plan and allocate resources, streamline design, production, procurement, marketing, sales, and finance.

ERP systems integrated with industry 4.0 tools such as Internet of Things and Artificial Intelligence are now available to organizations. ERP developers are also experimenting with shifting traditional software model to a cloud-based system for better configuring resources such network, storage and data which will further help this integration [36]. This new generation of ERP system improves the flow of data for easier decision making. By establishing a network-based resource sharing, these systems promote collaboration between different technology platforms.

2.3 Blockchain and Enterprise Resource Planning Systems Integration

Over the last decade Blockchain technology has found its applications in finance, supply chain management and operations. The ability of blockchain to establish digital trust between mutually distrusting parties and bring transparency to digital transactions has proved useful for organizational applications [34]. Trust, transparency, and traceability offered by blockchain is ideal for data exchange happening in contracts and financial transactions.

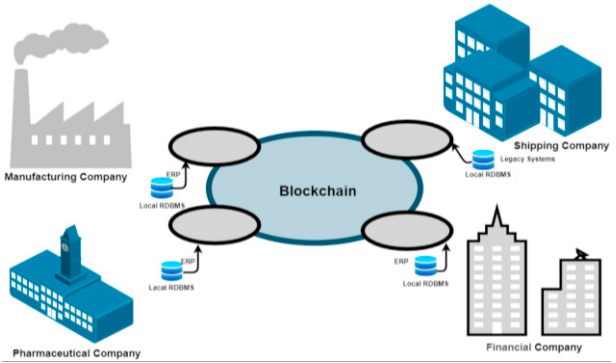

Fig.1. Integration of ERP system with Blockchain [4]

Additionally, blockchain is compatible with ERPs, supply chain management systems, warehouse management systems and customer relationship management systems [31]. As shown in fig.1 it can function as a decentralized immutable repository of organizational data that is accessible by all participants. The information collected by ERPs can be sent to blockchain and sent to be processed by smart contracts designed to meet the requirements of the organization. This will bring savings in cost and time and streamline operational procedures. By integrating ERP and Blockchain, the value propositions of blockchain such as its decentralized and distributed ledger can be enjoyed by any organization that needs it without disrupting its operating model.

There has been research that aims to investigate benefits of blockchain and ERP integration [31]. Several pilot projects and proof of concept have been proposed for its most efficient integration [1], [20]. Previous research has been focused on critical success factors of ERP [37] or critical success factors of blockchain [38]. However, there is scarce data regarding the success factors for blockchain and ERP integration. The merge of these two tools warrants a deep study of its merits and success factors. This systematic literature review will be building upon previous works focused on the same domain [21], [15].

3. Methodology

A literature review compiles, classifies, and evaluated the work by other researchers who works on a specific topic. A systematic literature review (SLR) is different from traditional narrative review. Systematic literature reviews identify knowledge in public domain and organizes it coherently [35]. It requires following a prescribed methodology which includes (1) definition of the research questions (2) design of the literature review plan (3) search for the relevant literature (4) setting inclusion and exclusion criteria (5) performing quality assessment and (6) ensure synthesis and reproducibility.

3.1 Research Questions

Clear and focused research questions are important for a successful systematic literature review. The research questions defined for this study are:

RQ1. What are the key success factors for integrating blockchain and ERP systems?

RQ2. In what context are these key success factors discussed?

3.2 Search for relevant studies

It is important to retrieve as many relevant studies as possible for a systematic literature review. To achieve this, this study has (1) defined a search string (2) selected databases and (3) performed data extraction. The results have been filtered to decide the relevance of the article pertaining to the research questions. The search string used was ‘Blockchain AND ERP OR Enterprise Resource Planning’. The databases selected for the search includes Science Direct, Emerald Insight, IEEE Xplore and MDPI.

3.3 Data extraction, screening, and evaluation

The inclusion and exclusion criteria for the articles selected are given in table 3.1. These criteria define the attributes of a paper chosen for the review. The criteria were developed with a focus on the research questions.

Table 1 – Inclusion and exclusion criteria

Exclude	Include
E1. Does not have a title, abstract or author	I1. Title, abstract or full text offers relevant answer to RQ1 or RQ2
E2. Cannot obtain the paper	I2. Peer reviewed and is credible
E3. Written in a language other than English	
E4. Does not constitute a research paper – articles, books, book chapters, review paper, thesis	
E5. The paper is a duplicate	

After compiling the results of the search and applying the exclusion and inclusion criteria, the flow of SLR is depicted in fig.2. Each paper reviewed were accessed for its validity and reliability.

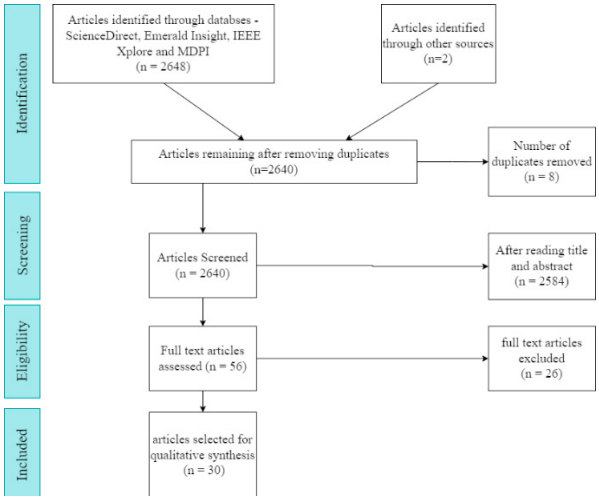

Fig.2. Paper selection process

The summary table of the literature obtained after the selection process in given in table 2. The table arranges the implementation context, the description of the context, the success factors, and the functional areas they correspond to.

3.4 Thematic Analysis

Content analysis was performed to evaluate the research questions. The authors quantify and analyze the keywords and phrases in the paper to estimate its relevance to the SLR. Thus, the articles of the SLR were chosen by the presence of relevant concepts and framework to present the research. After reading through the study, the factors identified were extracted. Then these factors were classified by their context and functional areas. Thus, thematic analyses were adopted to identify the key success factors of ERP and blockchain integration and identify the context and functional areas.

4. Results and Discussion

This section details the results of the thematic analysis and the success factors identified for blockchain and ERP integration. The findings are present in section 4.1 and section 4.2.

4.1 Descriptive Analysis

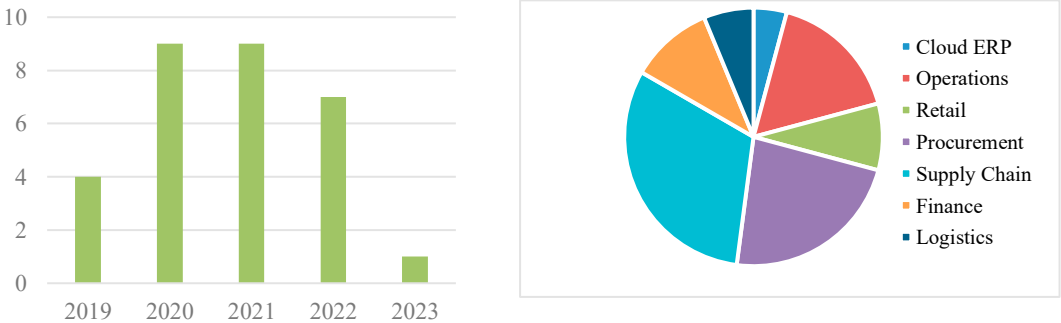

Fig.3. (a) Number of articles published per year; (b) Distribution of functional areas

Table 2 – Summary of the Selected Papers

Context	Description	Factors	Functional Areas Studied	Reference(s)
Trust-Related	Blockchain can implement digital trust between mutually distrusting parties. This trust is brought on by the decentralised ledger establishing traceability and transparency in the transactions. Any application of blockchain requires these needs to be met for success.	Traceability	Cloud ERP, operations	[24], [8]
		Trust	Operations, Retail Procurement, Food Supply chain	[12], [25], [29]
		Uniformity	Greek shipping industry	[16]
Business Process	The business process disrupted by blockchain is an important aspect that is discussed. Creating a digital identity for the organisation and working towards synergy between different functional areas are the first steps towards integrating blockchain with ERP. This may require innovating on the business model to accommodate for the strengths and weaknesses of blockchain. This will result in higher interoperability and higher efficiency for operations.	Business Model	Operations	[1]
		Business process re-engineering	ERP system	[28]
		Automation	ERP systems, e-procurement, operations	[30], [10], [13]
		Digital identity	Enterprise systems	[9]
		Synergy	e-procurement, Supply chain management, Cobalt mining supply chain, Accounting	[10], [5], [15], [26]
		Interoperability	ERP systems	[4]
		Efficiency	Supply chain management, Finance	[5], [20]
Technology	The type of blockchain and dependencies adopted will determine the success of blockchain and ERP integration to a large extend. Managers should decide on the option that offers optimum scalability, flexibility, and minimal disruption. Minimising disruption can be achieved by adopting tools that are compatible with the conventional enterprise resource management systems and those that have attained maturity to a certain level.	Architecture	Retail Logistics, operations	[18], [12], [14]
		Scalability	ERP systems	[4], [21], [6]
		Compatibility	Supply Chain Management, operations	[7], [1]
		Testing	Supply chain management	[11]
		Technology maturity	Cobalt mining supply chain	[15]
		Flexibility	e-procurement	[10]
		Technology infrastructure	Auditing	[19]
		Maintenance	Retail Logistics	[18]
Organisational	The organisational factors will be crucial in the success of blockchain and ERP integration. As a cost and time intensive investment, the right time to implement will be when the company is most prepared for a technological disruption. The scale and scope of the implementation should be also calculated to increase efficiency.	Company Readiness	Inter-company collaboration	[3]
		Sufficient digital infrastructure	ERP systems	[4]
		Timing decision	Cloud ERP	[17]
		Scale of Implementation	Retail Logistics, Accounting	[18], [19]
		Sustainability	Supply chain management	[5]
Regulatory	As a technology that is still maturing, the laws and regulation relating to its research and adoption is still unclear or non-existent in many markets	Data Security	e-procurement, ERP systems	[10], [4]
		Reduce errors and fraud	Supply chain management	[5]
		Compliance with regional laws	Supply chain, Cobalt supply chain, auditing, ERP system	[2], [15], [19], [23]
		Standardisation	Procurement	[25]
Capital	The costs associated with the implementation of blockchain, and ERP integration should match the financial return.	Cost of implementation	ERP system, supply chain	[23], [2]
		Operational costs	Supply chain	[2]
Employee perspective	Training the workforce through the integration will be crucial. The skills of an average employee should be upgraded to accommodate the demands of a highly technical and cutting-edge tool.	Interface	Supply chain management, Enterprise system	[11], [22]
		Technology skills	Operations, Enterprise system, procurement, Packaging Industry	[14], [22], [28], [27]
		Technological resistance	Cobalt mining supply chain, ERP system	[15], [23]

Fig. 3(a) indicates the number of articles published per year which were selected for the review. 2020 and 2021 shows higher number of number of articles published per year than any other. The period is markedly important because this period should drastic adoption of blockchain into workspace and further mapping the performance indicators and productivity levels will be able to provide insights on how well blockchain was implemented in the workspace. We can also see the literature slowed down in 2022 compared to previous year. Fig. 3(a) also indicates that the interest in blockchain and ERP integration is growing with more proof of concepts and pilot programs established in different markets. The low number of publishments in 2023 does not reflect a low interest as studies only published in print till May 2023 were considered for the review.

The distribution of functional areas for blockchain adoption is also interesting in this context. Fig. 3(b) depicts the distribution of functional areas for which blockchain, and ERP integration was implemented. We can observe blockchain predominantly serve the functional areas of supply chain and procurement. But the implementation context has strong influence on optimizing business processes. As blockchain can offer transparency and promote collaboration and mutual trust between unknown parties, it is one of the strongpoints of distributed ledger technologies. We can see a growing interest in blockchain implementation for finance. As a decentralized technology that emerged as the underlying technology for cryptocurrency, the ability of blockchain to handle financial transactions are well-established. As more and more business processes get automated, blockchain functionality will further the capabilities of ERP systems.

4.2 Key Success Factors

The key success factors for blockchain and ERP integration identified in this SLR is presented in Table 2. The table classifies the key factors, context of the success factors, and the functional area the factor corresponds to. From the table it is can be inferred that the key success factors for the integration of blockchain and ERP systems belongs in three main categories – technological, organizational, and regulatory. The technological factors include the architecture of the blockchain adopted, its compatibility with conventional ERP and data collection software, the IT infrastructure of an organization and the skills of the employees. [18], [12], [14], [15], [10]. The organization needs to be educated in the modern information technology tools.

Organization factors are key to success of information systems implementation, and they include structure and philosophy of the organization, leadership, resources and administrative support, and communication and coordination mechanisms. The organizational factors emphasized in this study belong primarily to the decision-making in business process. This includes the decision for capital investment, meeting maintenance and upgradation costs, preparing the company for the disruptions and automation of business processes [23], [2], [3], [4], [17]. The decisions regarding the scale of adoption and the timing of adoption are also identified as key success factors [17], [18], [19]. The managers should calculate the risks and benefits associated with integrating ERP and blockchain and make an informed decision regarding its implementation.

Regulatory policy and standards are third major factors affecting successful implementation of blockchain and ERP integration [2], [15], [19], [23]. This means that policy makers should catch up with the speed of research and development in the relevant space, particularly the advances in blockchain, ERP, and associated digital technologies, to make infrastructure and frameworks that will ensure the technology is beneficial for all [25]. This will also prevent bad actors in the network and increase the security of the platform.

The integration of blockchain and ERP is evolving and there will undoubtedly be many more contexts and factors that will influence successful integration. Whilst not explicitly accounted for in Table 2, environmental context can also be a key success factor in the integration of blockchain and ERP systems, particularly when sustainability is considered. Factors such as designing for environmentally friendly data centres, deployment using sustainable technology, and implementing a tailored integration can help reduce waste and increase sustainability performance of the integration effort. The project management context also matters, there must be a clearly defined scope, use of appropriate project management tools, stakeholder buy-in and support, proactive change management, and a myriad of factors associated with the software development methodology adopted.

5. Conclusion and Future Work

The key success factors for the integration of blockchain and enterprise resource planning systems were studied in this paper, using a systematic literature review methodology. These success factors can be broadly divided into three

contexts – organizational, technological, and regulatory. Managers and engineers who are working towards implementing ERP and blockchain integration should be able to consider and address these factors to ensure success and maximum efficiency. We were able to highlight adoption in functional areas related to supply chain and procurement. Further adoptions were seen in business process automation and business finance. As the integration matures and ERP systems can fully take advantage of the blockchain including smart contracts, non-fungible tokens, and other functionalities blockchain has to offer, we can expect to see further innovations and higher rate of adoption. This will certainly provide boost in productivity and increase performance.

While the systematic literature review is concluded with both the research questions answered, the lower number of papers taken into the review and the broad area it covers is a limitation. Further study into each functional areas and how the success factors are manifested needs to be studied in detail. Functional areas like finance, supply chain, operations need to have different relationship with blockchain and uses blockchain for different goals. Thus, more studies focused on these functional areas needs to be carried out. Future work on the integration of ERP systems with decentralized ledger technologies from an implementation, deployment, and business process perspective that exploits an understanding of the key success factors will be valuable.

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