

The Role of Blockchain, Big Data and Cloud Computing in Modern ERP Implementation

La Ode Abdul Manan¹, La Panga² and Mahmoud A. Mahmoud³

¹Department of Management, Universitas Sulawesi Tenggara, 93126 Kendari, Indonesia

²Department of La Panga, Universitas Sulawesi Tenggara, 93126 Kendari, Indonesia

³Department of Medical Instrumentation Techniques Engineering, Dijlah University College, 10021 Baghdad, Iraq
abdulmanan@un-sultra.ac.id, lapanga@un-sultra.ac.id, mahmoud.abbas@duc.edu.iq

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Abstract: Modern Enterprise Resource Planning (ERP) systems are achieving significant advancements in scalability, data processing, security, and transparency through the integration of cloud computing, big data analytics, and blockchain technology. This research examines the transformative impact of these technologies on ERP implementations within Polish enterprises. Through an extensive organizational survey, we investigate: 1) current levels of technological knowledge, 2) organizational readiness for adoption, and 3) perceived business impacts. The study provides novel insights into the crucial role played by public sector initiatives in facilitating widespread technology adoption, particularly emphasizing their influence on organizational readiness and policy-driven incentives. Furthermore, the research identifies critical implementation challenges such as infrastructure constraints, resistance to organizational change, resource limitations, and highlights significant security and privacy concerns associated with each technological approach. These comprehensive findings offer valuable contributions to both the theoretical understanding of technology integration frameworks and practical implementation strategies, especially for deploying next-generation ERP systems within transitional economies. By addressing these multifaceted aspects, the study equips policymakers, business leaders, and IT practitioners with actionable knowledge to navigate the complexities inherent in large-scale digital transformations.

1 INTRODUCTION

A fast-paced, digital-first business environment depends increasingly on modern technology to increase efficiency, improve decision-making, and drive innovation. Enterprise Resource Planning (ERP) is no longer just about finances, human resources, and supply chains. It has become an integrated, comprehensive tool. In the last decade, cloud computing, big data, and blockchain technology have all had significant effects on the way ERP systems are implemented and utilized, transforming their use and implementation. Due to its scalability, cost-effectiveness, and accessibility, cloud-based ERP enables businesses of every size to benefit from powerful, scalable, and cost-effective systems. The use of big data in ERP systems allows real-time analytics to be performed. The ability of organizations to make data-driven decisions is critical to improving efficiency, optimizing operations, and anticipating market trends. Furthermore, blockchain

ensures tamper-proof, accountable, and easily auditable business transactions by enhancing transparency, security, and traceability [1].

The convergence of these technologies is reshaping ERP implementations, allowing businesses to improve collaboration, streamline operations, and drive innovation. Using cloud computing, big data, and blockchain, the paper explores the benefits, challenges, and potentials of these technologies in transforming business processes and driving business success.

During the ERP implementation process, organizations are faced with many additional tasks and changes to their organizational structure. In terms of organization, technology, and economic complexity, implementation is continuously increasing [2]. It is very common for implementation projects to fail due to the necessity of making these changes. As ERP implementation is discussed in this article, blockchain, big data, and cloud computing technologies are discussed as well.

A proper project methodology reduces failure risk. In 2015, the Standish Group's CHAOS Report, a study that tracks IT project failures, found that 29% of all projects were successful and 19% were unsuccessful. [3]. Report results from 2020 indicated a 31% success rate and a 19% failure rate for the projects [4]. Panorama Consulting Group reports show slightly different results, as successful projects increase year over year. The 2018 ERP implementation rate was 42% [5], while the 2019 implementation rate was 88%.

Many researchers believe that Sustainability and societal development are closely related, for example, in the cases of households [6], [7], governments – particularly local government [8] – and business. Households, government units, and enterprises will be able to measure the progress of an information society in a sustainable way with synthetic indexes. In Poland, a measurement model based on sustainable information society has been developed and documented through research studies. In these sectors, ICT adoption factors can be divided into four groups based on their importance - economic, ecological, sociocultural, and political factors, with economic factors being the most significant [9]. Many of the technologies associated with Industry 4.0 and Society 5.0 make use of ICT research specifications, including cloud computing, big data, etc [9].

The Author [10] describes in detail the methodology phases of using blockchains, big data, and cloud computing, proposing and developing the concept relating to their use. Taking into account the mentioned technologies, a methodology for implementing ERP was developed using a literature review on success factors and a case study analysis. ERP systems are helpful for managing multinational companies' complex processes [9]. Increasingly, emerging technologies such as cloud computing, big data analytics, and blockchain are playing a significant role in ERP implementations [11]. Through these technologies, ERP systems are expected to become more scalable, data-processing capable, transparent, and secure. A discussion of how cloud, big data, and blockchain are transforming ERP implementations in the 21st century will be explored in this introduction. The report also includes a review of current trends and challenges in the field as well as directions for the future. There are limitations in traditional ERP systems that focus on individual enterprises and don't facilitate seamless interactions between enterprises on a global scale [12]. By combining cloud computing, big data, and blockchain technologies, we can achieve greater decentralization and unified functionality [13]. A cloud ERP solution

provides businesses with the capability of supporting and coordinating key business processes [14]. Big data technologies enable the system to respond efficiently to massive amounts of data To increase ERP responsiveness [15]. By introducing decentralization, blockchain technology could revolutionize how organizations work within unified ecosystems. In this paper, we examine cloud computing, big data, and blockchain technologies from the perspective of ERP implementation [16]. Utilizing current methodologies, this paper analyses the factors influencing the successful adoption and integration of these technologies. Several technologies are discussed in this paper, including cloud computing, big data, and blockchain technology. Researchers and practitioners can benefit from this paper by providing valuable information regarding how these technologies affect ERP implementation processes. In addition, this study serves as a guide to navigating the ever-changing business landscape shaped by technological advancements and globalization.

2 LITERATURE REVIEW

In [17] identifies nine customization options based on the extent of changes made to both the ERP system and the business process. Organizations can use it to determine whether customization options are feasible based on their capabilities and understand what customization options are available. A case study demonstrating the framework's applicability involved the phased implementation of several ERP modules. A comprehensive and up-to-date review of how blockchain and cloud of things (CoT) can work together is presented in [18]. As a result of its advantages in security, privacy, and support, this integration has gained traction in industrial applications. In response to the survey, we reviewed BCoT systems in depth to fill the existing knowledge gap.

In his paper, the author proposes a framework with an ERP module that can be used for tracking quality requirements and accreditation at universities [19]. A dedicated database and linkages with other university systems facilitate the generation of required reports and statistics. QAAM (Quality Assurance and Accreditation Module) facilitates the collection, analysis, and reporting of quality and accreditation data. According to the author [20], a framework has been developed to provide smart objects as a service, utilizing context-aware concepts and accounting for bandwidth, scalability, and

performance constraints. In addition to the data acquisition and management services, this framework includes rules reasoning and data aggregation. Using an IoT network simulation, the study validated and evaluated the framework's effectiveness [21].

2.1 ERP Systems: Evolution and Challenges

MRPII and CIM were the precursors to Requirement Planning, which has a long history. It has become increasingly complex for these systems to integrate various business functions into one platform. Automation of processes and operations, improved data integrity, and cost reduction are the primary goals of ERP systems [22]. In addition to high implementation costs, complexity, and customization requirements, traditional ERP systems also pose challenges [23].

2.2 Cloud Computing and ERP

ERP systems on premises are becoming obsolete due to cloud computing [24]. Numerous benefits can be gained from cloud-based ERP solutions, including lower upfront costs, rapid deployment, scalability, and cost-effectiveness. Organizations of all sizes can benefit from cloud ERPs because of their virtualization capabilities. A cloud ERP system is quicker to implement, has a lower cost, and is easier to use than an in-house ERP system, according to research.

There are, however, some challenges associated with cloud ERP adoption. Organizations need to address many sociotechnical considerations, such as the fit between functionality and system, the integration of systems, the migration of data, and the security of their processes. Since cloud ERP has lower costs and is more easily implemented, small and medium businesses (SMEs) can particularly benefit from it [25]. Larger organizations, however, often require hybrid solutions that combine cloud and on-premise technologies due to their size, complexity, and specific needs. Many factors can influence an organization's decision to adopt a cloud-based ERP system, including culture, regulatory context, relative advantages, trialability, and vendor lock-in [26].

2.3 Big Data and ERP

To enhance ERP systems' responsiveness, big data technologies are integrated to make them more efficient at handling large amounts of data. To make better decisions and improve performance, big data

technologies analyze and manage complex data sets [27]. When data is filtered, analyzed, and compared, organizations are able to spot trends, patterns, and anomalies that might otherwise be hard to notice. While big data technologies can offer many benefits, it is often difficult for organizations to integrate ERP systems with them. It is challenging to manage large data volumes, identify relevant data, and transform that data for use by the ERP system. Contextualizing data and managing big data are factors that organizations can use to address these challenges. As a result of the integration of big data in ERP systems, organizations and supply chains can perform better, resulting in higher profitability [28].

2.4 Blockchain Technology and ERP

Blockchain technology enables decentralized and transparent data management, which addresses some of the limitations inherent in traditional, centralized ERP systems [29], [30]. By integrating blockchain with ERP, businesses can enhance their security, enhance their data integrity, and facilitate seamless interactions with each other. Auditing, compliance, and accountability are just a few of the ways blockchain can improve ERP systems. With blockchain in ERP, e-procurement can be integrated at multiple levels and become more efficient, productive, and secure. A blockchain-based accounting information system (AIS) offers immutability and confidentiality [31]. Organizations can safeguard financial accounting data using blockchain technology by creating data vaults. Supply chain management can also be revolutionized with blockchain integration, which ensures visibility and traceability [32].

3 METHODOLOGY

A description and analysis of the phenomenon were conducted using descriptive-analytical methods. In Jordanian commercial banks, cloud auditing plays a role as an intermediary between the bank and the cloud ERP system, which impacts blockchain networks. Data was collected through a survey, and variables, opinions, processes, and effects were analyzed.

3.1 Study Population and Sample

A variety of management levels were represented in this unit, including upper management, middle management, and lower management. There were

heads of finance, audit, risk, human resources, and technology departments in Jordanian commercial banks, along with general managers and their deputies, department heads, section heads, and unit heads. Because it proved difficult to estimate employee numbers for the departments listed above, 15 questionnaires were sent out to a wide range of employees in each bank. We distributed 180 questionnaires, 167 of which were valid for statistical analysis. There was a retrieval rate of 92% of the questionnaires distributed.

3.2 ERP Implementation and Blockchain Technology

Generally, distributed ledger technologies (DLTs) are distributed ledgers that provide a duplicate copy of the database to each node of a network, which can be accessed and modified independently of each other. There is a database that can be consulted by all nodes that own a copy but can only be modified by a central authority (or more validators). A consent-based system governs the change of the register in such a case. Despite the fact that each ledger version is updated independently by network participants, these algorithms allow a consensus between them. The security and immutability of distributed ledgers and blockchains are maintained by cryptography in addition to consensus algorithms [33].

Networks can be classified into three types: networks - networks that anyone can access. Systems with permissions have an easier consent process. Nodes propose transactions by checking their validity, and a majority vote determines whether to include them in the ledger. Unlike permissioned systems, permissionless systems require more complex consent mechanisms (such as proof of work or proof of stake) to prevent malicious actors from creating false identities [34].

3.3 ERP Big Data Analytics

In ERP systems, big data analytics represents a significant advancement in strategic decision-making. Analyzing Big Data can provide actionable insights from increasingly abundant and complex data. As we discuss in this section, ERP and its applications can benefit from Big Data Analytics.

3.3.1 A Modern ERP System's Role in Big Data

Analyzing large, diverse data sets is a crucial part of ERP systems' Big Data Analytics. A deeper

understanding of business operations is possible thanks to enhanced data processing capabilities provided by ERP systems.

3.3.2 ERP Applications of Big Data

3.3.2.1 Improved Decision-Making

As a result of Big Data Analytics, businesses can gain a deeper understanding of operations, customer behaviour, and market trends.

3.3.2.2 Business Process Predictive Analytics

Big Data in ERP is used to conduct predictive modelling in supply chain management, inventory control, and customer relationship management, among other areas.

3.3.2.3 Enhanced Operational Efficiency

A business can improve overall efficiency by streamlining processes and identifying operational bottlenecks by analyzing large datasets.

3.3.2.4 Customer Insights and Personalization

In addition to providing businesses with better products and services, ER Phelps' Big Data can be used to enhance customer engagement. Business technology has evolved significantly since Big Data Analytics is integrated into ERP systems. In addition to enhancing ERP systems' functionality and strategic value, Big Data Analytics unlocks the potential of vast datasets. The challenge, however, lies in addressing compliance, data quality, and integration complexity to make these benefits a reality. Achieving operational excellence through Big Data Analytics in the ERP landscape requires successfully navigating these challenges [35].

3.4 Environmental Performance and Sustainable Enterprise Resource Planning

Managing Sustainability effectively requires integrating sustainability information systems, according to previous research [36]. Additionally, S-ERP is a green IT solution that integrates sustainability-related data into one central database and captures, automates, monitors, and integrates it. Sustainable data is not typically captured and managed by traditional ERPs (information systems) [37], [38]. An ERP integrated with a

material flow cost accounting system facilitates better decisions regarding waste management, according to the Author [39]. By combining ERPs and lean manufacturing practices, waste generation can be reduced, and environmental impact may be improved [40], [41].

ERPs are primarily focused on profit, while S-ERPs are primarily concerned with profit, the planet, and people. Organizations that implement sustainability enterprise resource planning (S-ERP) integrate their data, operations, and business functions [37]. As a result, S-ERPs streamline sustainable processes, benefiting the environment in the long run [37]. Corporate sustainability strategies are more effective when S-ERPs are used, and environmental resources are more effectively managed, according to the article [42].

Furthermore, [43] demonstrated that incorporating "green" metrics into ERPs and interacting with environmental management IS is one of the most effective sustainability management alternatives. Despite its rarity, ERP vendors rarely provide this option. SAP and Microsoft are among the few ERP vendors that include sustainability KPIs [44]. In accordance with the author's observations [45], S-ERPs can be useful for reducing greenhouse gas emissions, conserving energy, and reducing costs for companies. It must be noted, however, that the S-ERP concept has not yet been widely adopted in a real-world setting, as reported by [37]. Lean principles can also be challenging to implement in the construction industry when it comes to reducing waste through the implementation of ERP [41].

It requires adapting to new data formats, integrating new sources of data, and engaging new stakeholders than ERP implementations [37], [42]. There is a possibility that the outcome will not be effective, so the sustainability objective will not be met. Consequently, S-ERPs need to be investigated for their impact on the environment. In light of this, we propose the following hypothesis:

3.5 Social Performance and Sustainable Enterprise Resource Planning

Social performance is a measure of how an ERP affects the work environment, knowledge, training, and experience of employees, as well as their resistance to change [45]. Business activities can aid in building trust with vendors, involving employees in decision-making, and enhancing knowledge that can't be duplicated by rivals, according to [46].

The author [47] identified a number of KPIs that contribute to ERP adoption, including collaboration

among employees, employee empowerment, sustainability, scalability, and flexibility. Due to the fact that managers and employees have both control and influence over ERP systems, managers and employees are the primary stakeholder groups for ERP systems. The implementation of ERP also creates new skills for employees since it requires them to acquire new knowledge. In light of this, ERP training is recommended during the implementation phase.

4 RESULTS AND DISCUSSION

Two of the three selected enterprises were experienced in big data and cloud computing, as well as blockchain technology. Figure 1 illustrates Poland's technological trends, which are encouraging.

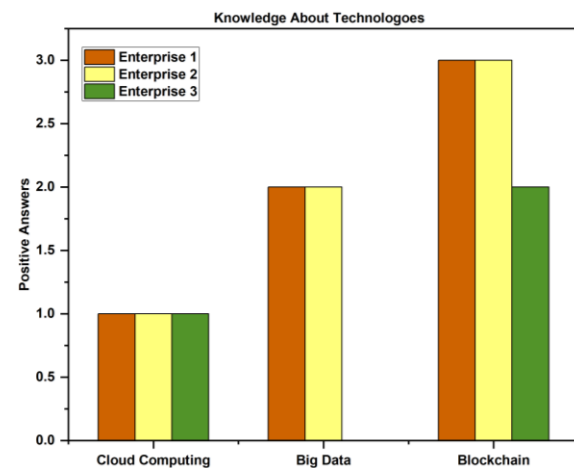


Figure 1: Know-how about technologies within the enterprise.

Furthermore, participants were asked to determine whether they felt that such technologies were necessary or willing to be adopted within their companies and which departments or areas they believed these innovations would be beneficial to. As depicted in Figure 2, all selected enterprises recognized the need for big data adoption; two were open to cloud computing adoption, and one was interested in blockchain technology adoption.

Government support for the development of these technologies was either not mentioned by participants or acknowledged, but with the caveat that more urgent priorities should be considered first. It was aligned with their willingness to adopt these technologies when it came to the impact they thought those technologies would have on project success.

Big data implementation influenced all participants, cloud computing influenced two, and blockchain influenced one, as shown in Figure 3.

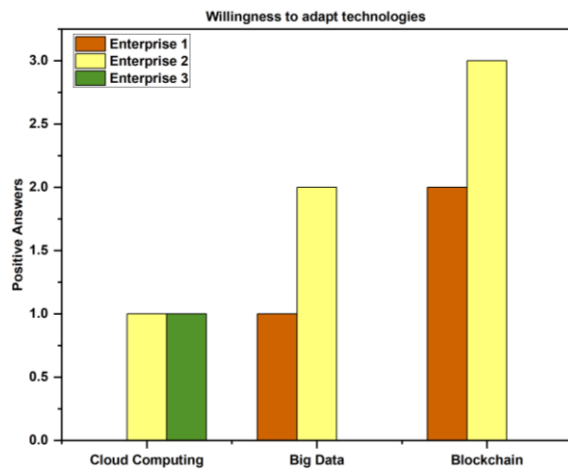


Figure 2: Technology adoption by enterprises.

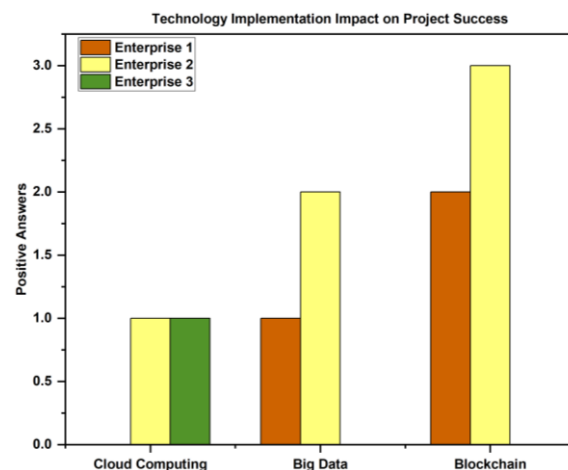


Figure 3: A successful project depends on the implementation of technology.

Generally, each technology was perceived to present few potential threats. According to most participants, none of the technologies mentioned pose a significant threat. Participants expressed concern about each of the three, however. There is a potential threat to blockchain development posed by "data availability," a potential threat to big data posed by "lack of flexibility," and a potential threat to cloud computing posed by "intellectual property rights", as in the following Figure 4.

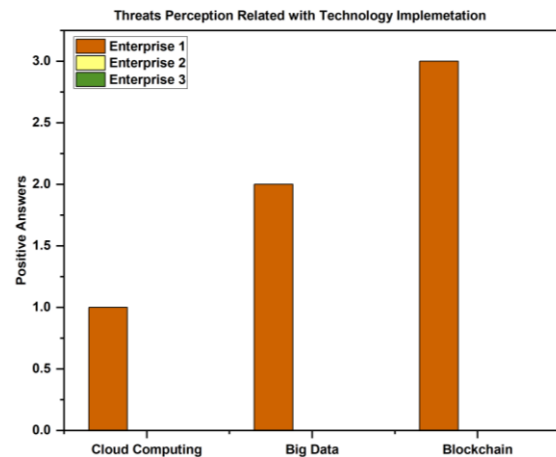


Figure 4: Implementing technology poses a threat to perceptions of threat.

5 CONCLUSIONS

Blockchain technology, big data, and cloud computing play a crucial role in modern enterprises' ERP capabilities. Big data and cloud computing are highlighted as technologies Polish businesses are willing to adopt. Although there is optimism about the future of these technologies, concerns remain regarding the need for government support and the potential threats they pose. As a result of effectively integrating these advanced technologies, substantial improvements in operational efficiency, security standards, and strategic decision-making processes can be anticipated. Organizations may benefit from streamlined workflows, enhanced data protection, reduced operational costs, and more informed managerial insights. Nevertheless, practical implementation continues to face significant challenges, particularly related to maintaining data flexibility, addressing complex intellectual property rights issues, and ensuring seamless system integration across diverse platforms. These factors demand careful consideration to prevent disruptions in business continuity. Therefore, future research must prioritize developing pragmatic methodologies for embedding these technologies within existing ERP frameworks. Additionally, in-depth investigations into their long-term effects on business sustainability, market competitiveness, environmental responsibility, and overall organizational performance should be conducted to provide comprehensive guidance for stakeholders.

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