Measuring Enterprise Resource Planning (ERP) Software Risk Management for Digital SMEs

Dorojatun Prihandono[*], Angga Pandu Wijaya, Kris Brantas Abiprayu, Widya Prananta, Syam Widia

Department of Management, Faculty of Economics and Business, Universitas Negeri Semarang, Semarang 50229, Indonesia

Corresponding Author Email: dprihandono@mail.unnes.ac.id

ABSTRACT

The research aims to analyze risk management in the adoption of Enterprise Resource Planning (ERP). ERP currently widely used, however limited research focus on risk management adoption regarding technological and information system. Digital transformation encourages SMEs to adopt information technology to streamline business processes, especially ERP. Through a comprehensive investigation involving 85 SME owners, the study focuses on ERP risk management. The analysis is conducted by identifying, mapping, and assessing severity. Additionally, data is analyzed using a neural network to explain the satisfaction level of ERP adoption. The research identifies several key risk factors, including vendor stability, data security, system downtime, and inadequate support. Based on research result, risk management underscores the need for robust encryption protocols, access controls, and regular security audits to mitigate the risks of data breaches, unauthorized access, and the compromise of critical business data. The research is reliable in illustrating ERP adoption risks, with a 98.3% correct prediction rate. The novelty of this research lies in its identification and mapping of risk factors in ERP adoption for SMEs, serving as an alternative reference for determining information technology improvements. The research suggests prioritizing thorough due diligence when selecting an ERP vendor and establishing clear and comprehensive Service Level Agreements.

1. INTRODUCTION

At present, SMEs in Indonesia have experienced rapid growth, which intersects with the adaptation and penetration of digital business [1]. The transformation of SMEs is crucial in providing optimal services to consumers. This transformation necessitates tools to handle increasingly complex and complex tasks. Enterprise Resource Planning (ERP) systems are indispensable for SMEs involved in intricate business operations. ERP constitutes a vital component in the development of digitally-oriented SMEs. The advancement of SMEs towards digital business necessitates adequate software. While ERP systems are widely utilized by large enterprises, their adoption by SMEs is burgeoning in business development [2]. ERPs offer solutions for SMEs to manage processes involving multiple departments such as finance, human resources, inventory management, and customer relations. An ERP system furnishes an integrated platform that streamlines these multifarious functions, ensuring efficient communication and collaboration across the organization. ERPs aid in tackling the challenge of managing vast amounts of data generated from various business activities. Centralizing data storage and management, ERP systems mitigate the risks of errors, duplication, and data inconsistencies, thereby facilitating better decision-making through real-time insights and comprehensive analytics,

enabling rapid adaptation to changes and informed strategic decision-making.

Previous research has extensively identified risk management for SMEs [3, 4], yet there remains a inadequacy of research focused specifically on ERP software for SMEs. Despite the pivotal role of ERP systems in contemporary business operations, research focused on ERP risk management remains relatively limited. While ERP systems offer numerous benefits, they also introduce potential risks and challenges that organizations must address [5]. However, academic and industry research in this specific domain has not kept pace with the widespread adoption of ERP solutions.

The complexity and variability of ERP implementations across different industries and organizational contexts constrain research on ERP risk management. ERP systems are highly customized to meet specific business needs, making it challenging to develop universal risk management frameworks. Additionally, the rapidly evolving nature of ERP technology and the continuous updates and advancements in ERP solutions pose ongoing challenges for researchers to keep abreast of the latest developments. Furthermore, organizations may be reluctant to divulge detailed information about their ERP implementations, especially concerning the challenges and risks they encounter. This reluctance may stem from concerns about exposing vulnerabilities or competitive disadvantages. Based on the explanation, the mapping

required for analyzing risk management in the use of ERP, particularly in the context of SMEs, remains unclear. This mapping presents a challenge that necessitates further investigation in the utilization of ERP systems. The research outlines the potential risks that SMEs may face when implementing ERP. The objective of this research is to map out the risk management of ERP usage for SMEs. This mapping aims to encourage more extensive ERP utilization, as it holds the potential to foster business growth while considering business risks.

2. LITERATURE REVIEW

ERP has evolved since their first emergence [6]. Started as simple tools to more sophisticated that integrate with business processes in organizations [7]. At first, ERP used to make accounting and financial functions more seamless, but then over the time, they expanded to cover more functions such as supply chain management, human resources, and customer relationship management [8]. Even nowadays, with the advancement of technology made the cloud-based ERP is possible which could improve the scale and flexibility and making ERP more attractive to SMEs [9].

ERP systems have become indispensable tools for organizations aiming to streamline and integrate their diverse business processes. Traditionally, the primary focus of ERP systems has been on improving operational efficiency and ensuring data accuracy in areas such as finance, human resources, and supply chain management. However, the ever-evolving business landscape has prompted a paradigm shift in the role of ERP systems. The historical evolution of ERP systems traces their journey from being mere transactional tools to becoming comprehensive solutions for managing enterprise-wide functions [10, 11]. Early ERP implementations focused on addressing specific business challenges and improving efficiency. Scholars highlight how ERP systems have evolved over time to encompass a broader spectrum of organizational processes [12, 13]. Despite their initial successes, organizations began facing limitations as they grappled with growing complexities, leading to the realization that traditional ERP systems were insufficient in addressing contemporary challenges.

The adoption of ERP system in business functions not only limited to large companies but also SMEs [14] and it is more important than ever for SMEs as they need to make sure to remain competitive in evolving digital business. However, to some extent, the implementation of ERP in SMEs faces certain challenges that come from financial limitations, resource availability and risk management. Prior research show that the struggle of SMEs often comes in form of the complexity of ERP itself, vendor selection and problems in integration [15, 16]. In addition, another such as data silos, system complexity, and resistance to change are identified as common obstacles [17]. Ensuring seamless communication between different modules and fostering a risk-aware organizational culture are critical factors that researchers emphasize in successful implementations. Understanding and addressing these challenges are crucial for organizations seeking to leverage the full benefits of risk management ERP systems. These challenges potentially become the biggest risk factor for ERP implementation in SMEs [18].

The integration of risk management functionalities into ERP systems represents a pivotal response to the limitations identified in traditional ERP implementations. Researchers discuss the significance of incorporating risk management into ERP systems to address emerging threats and uncertainties [19]. This convergence aims to empower organizations with proactive risk mitigation strategies, fostering a resilient business environment. Prior research shows how beneficial the integration of ERP system with risk management in company. ERP could offer high capability in data centralization which could help risk management to identify the potential risk in real time [20]. Even if we go beyond, the usage of artificial intelligence and big data analytics could help RPS system to be able to predict risk with their potential solutions even before the problems happened [19]. These features could elevate the risk management practices for SMEs as they usually do not have the dedicated risk management standard operating procedures. However, the implementation of AI based ERP in SMEs still underexplored and limited [6].

The literature underscores the need for ERP systems to go beyond operational efficiency and actively contribute to organizational risk management strategies. Current literature highlights several key trends in risk management ERP software. Cloud-based ERP solutions are gaining prominence, offering flexibility and scalability in managing risks associated with data security and accessibility. Additionally, advancements in analytics and artificial intelligence within ERP systems enable organizations to proactively identify and respond to potential risks. Integration with external data sources and real-time monitoring are becoming critical features, allowing organizations to stay agile in the face of rapidly evolving risk landscapes [21].

While the integration of risk management functionalities into ERP systems holds immense potential, it is not without challenges. The literature consistently highlights the potential benefits of integrating risk management into ERP systems. Improved decision-making, enhanced visibility into organizational risks, and increased agility in responding to dynamic environments are some of the touted advantages. Organizations can achieve a more comprehensive understanding of their risk landscape, leading to proactive risk mitigation strategies and a competitive edge in the market [22]. The alignment of risk management with overall business objectives is emphasized as a key outcome of successful implementations.

Despite all that potential that could be unlocked, within the realm of research, the gaps remain especially regarding SMEs. The major stream of ERP research for risk management developed to fit large companies and lacking the insight from SMEs [7]. Even some researcher still has concern on the contributions of previous ERP research that lacking multi-sector perspectives [6, 7]. In addition, there is still lack of research regarding the implementation of more sophisticated ERP system (e.g. cloud-based ERP system) for SMEs [15].

This study aims to fill the gap on the lack of empirical evidence on ERP risk management within SMEs context. By focusing on vendor stability, data security and system cooldown, this study attempts to reveal the understanding of risk that SMEs faced during the adoption of ERP in small enterprises. The novelty of this research lies in the use of neural networks and their effect to the succession of ERP adoption in SMEs.

3. METHOD

The research employs a quantitative approach to analyze data sourced from SME owners. SME owners, as respondents, are asked to fill out the "risk likelihood," which refers to the probability or chance that a particular risk will occur. Assessing the likelihood of various risks helps organizations prioritize and plan for potential challenges. Risk likelihood is measured using a scale of 1-5. Respondents also provide input on "impact," which indicates the effect or consequence that a particular risk event may have on an organization's objectives, projects, or operations. The measurement also examines "velocity," defined as the speed or rate at which a potential risk event is expected to occur, expressed in units of time such as days, weeks, months, or years. Moreover, respondents also assess "preparedness," which refers to the proactive measures and planning that an organization undertakes to anticipate,

respond to, and recover from potential risks. The measurement of types of risk is shown in Table 1.

The research involves SMEs from various sectors in Indonesia, with a total of 85 SME owners completing the questionnaire aimed at analyzing risk management in adopting ERP in business.

The data obtained from 85 respondents is then analyzed using heat map analysis visualization. The utilization of heat map visualization aims to map out business risks for digital SMEs in using ERP. Neural networks are valuable for organizations seeking to enhance their ERP systems and address potential issues that may affect user satisfaction. The neural network can identify correlations and dependencies between different variables and user satisfaction levels, providing insights that can inform decision-making regarding system improvements, user training, or system customization.

Table 1. ERP risk description

Risk ID	Types of Risk	Risk Identification
1	Complexity	ERP implementations can be complex, complexity analize the delays and cost overruns
2	Integration Issues	Integration issues measure ERP integration with current systems and external applications
3	Lack of Flexibility	Flexibility calculate ERP systems adaptation to evolving business processes and scalability
4	Vendor Stability	Vendor stability refers to selection of stable vendor and track record to receive ongoing support and updates.
5	Data Security	Identifying, assessing, and mitigating potential threats and vulnerabilities that could compromise the confidentiality, integrity, and availability of sensitive information within the ERP system
6	Access Controls	Access controls refer to the mechanisms and policies implemented to regulate and manage the entry and usage of resources within a system or network.
7	Scalability Issues	The ERP system may struggle to accommodate the business's growth or evolving needs
8	System Downtime	System downtime refers to a period during which a computer system, network, application, or service is unavailable or not operational.
9	Inadequate Support	Limited or inefficient customer support from the ERP vendor can impact issue resolution.

4. RESEARCH RESULT

Based on the research findings regarding ERP risk assessment, a map of ERP usage risks can be presented. The risk map constructed in this study refers to respondents' answers regarding the risks of using ERP.

Based on Table 2 and Figure 1, ERP implementation SMEs presents unique challenges, with "complexity," "data security," and "system downtime" emerging as high-risk factors. Limited resources are a central issue, with smaller teams often grappling with the intricacies of ERP complexity. Unlike larger enterprises that might have dedicated IT departments, SMEs may lack the specialized expertise required for comprehensive ERP configuration and customization. The complexity inherent in ERP systems can strain the capabilities of these smaller teams, increasing the

risk of errors during implementation. This complexity challenge is further accentuated by potential skill gaps within SMEs, making it imperative for these businesses to carefully navigate the intricacies of ERP adoption.

Data security stands out as another significant risk for SMEs undertaking ERP implementations. SMEs typically operate with constrained budgets, and allocating sufficient resources to robust cybersecurity measures becomes a challenge. The limited financial capacity may compromise the implementation of comprehensive security protocols, leaving SMEs more vulnerable to data breaches. Given that ERP systems centralize vast amounts of sensitive business data, including financial information and customer details, a breach could have severe consequences for an SME, making data security a critical risk factor that demands careful consideration and mitigation strategies.

Table 2. Result of ERP risk identification

RISK ID	RISK CATEGORY	IMPACT	PROBABILITY	VELOCITY	PREPAREDNESS	HEAT MAP X	HEAT MAP Y
1	Complexity	2.0	4.0	3.0	4.0	6	16
2	Integration Issues	3.0	3.0	2.0	4.0	6	12
3	Lack of Flexibility	4.0	2.0	3.0	3.0	12	6
4	Vendor Stability	3.0	4.0	3.0	3.0	9	12
5	Data Security	3.0	4.0	3.0	4.0	9	16
6	Access Controls	3.0	3.0	3.0	2.0	9	6
7	Scalability Issues	3.0	2.0	3.0	1.0	9	2
8	System Downtime	4.0	4.0	3.0	4.0	12	16
9	Inadequate Support	4.0	4.0	3.0	3.0	12	12
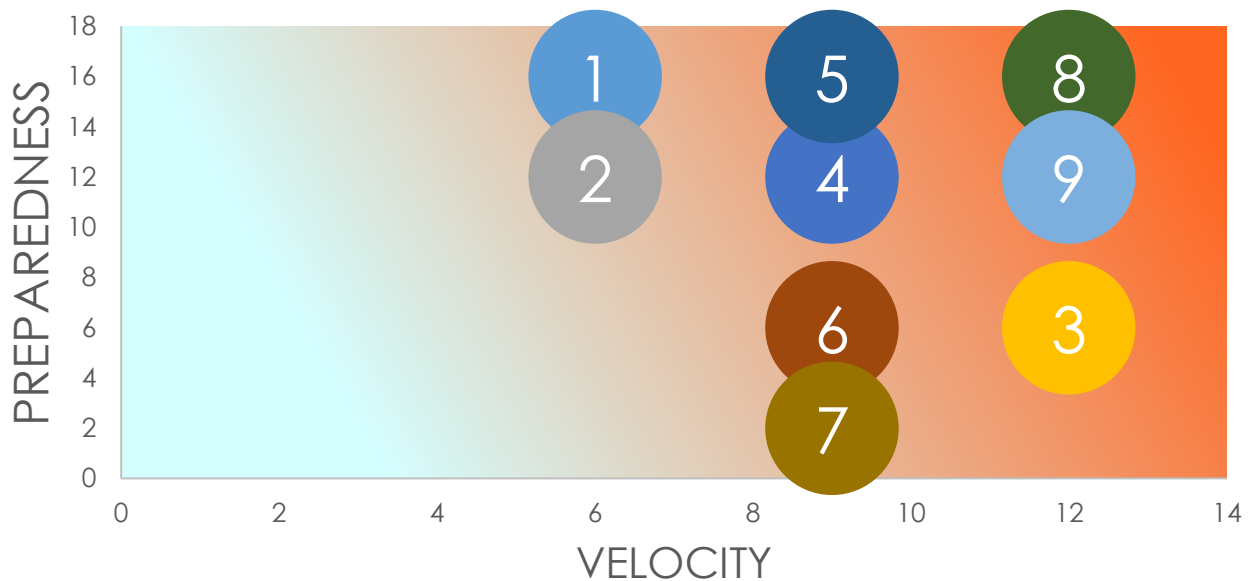
Figure 1. ERP risk mapping

System downtime is a high-risk factor for SME ERP implementations due to its potential impact on business continuity. SMEs often operate with leaner margins and may lack the redundancy and backup systems that larger enterprises can afford. ERP implementation processes can disrupt regular business operations, leading to downtime that SMEs can ill afford. This downtime can result in delays, impacting customer service, order fulfilment, and overall productivity. For SMEs heavily dependent on efficient and continuous operations, the risk of extended system downtime during ERP implementation poses a significant challenge that requires meticulous planning and risk mitigation efforts. In essence, addressing the challenges of complexity, data security, and system downtime is crucial for SMEs to reap the benefits of ERP systems while minimizing potential disruptions and setbacks.

Another key consideration is "data security." ERP systems centralize a vast array of sensitive business data, including financial information and proprietary details. Inadequate data security measures pose a severe risk, especially for small and medium-sized enterprises [19]. Insufficient financial resources may constrain these businesses in implementing robust cybersecurity measures, making them more susceptible to data breaches [23, 24]. Given the potential consequences of unauthorized access or data loss, the risk associated with data security demands meticulous attention and mitigation

strategies during the ERP adoption process. Vendor faces financial instability or undergoes organizational changes, there is a heightened risk of discontinued support or updates for the ERP system. This can potentially leave businesses in a precarious situation, lacking the necessary assistance and updates required for the optimal functioning of their ERP solution.

When assessing the adoption of ERP based on risk severity, as shown in Table 3 and mapped in Figure 2, several critical aspects merit vigilant consideration. One such aspect is "vendor stability." The stability and reliability of the chosen ERP vendor hold significant importance as they directly influence the long-term success of the implementation. If the "System downtime" emerges as a critical risk factor during ERP adoption, particularly for businesses with limited operational redundancy [3]. SMEs, in particular, often operate with leaner margins and may lack the backup systems available to larger enterprises. The implementation process can disrupt regular business operations, leading to downtime that SMEs can ill afford. Extended periods of system downtime may result in delays, impacting customer service, order fulfillment, and overall productivity. Mitigating the risk of system downtime necessitates careful planning and strategic measures to minimize disruptions during the ERP implementation phase.

Table 3. ERP risk severity score

REF ID	RISK DESCRIPTION	LIKELIHOOD 1-5	IMPACT 1-16	RISK SEVERITY SCORE Prob x Impact
R1	Complexity	2	16	32
R2	Integration Issues	3	8	24
R3	Lack of Flexibility	4	4	16
R4	Vendor Stability	3	16	48
R5	Data Security	3	16	48
R6	Access Controls	3	8	24
R7	Scalability Issues	3	2	6
R8	System Downtime	4	16	64
R9	Inadequate Support	4	16	64
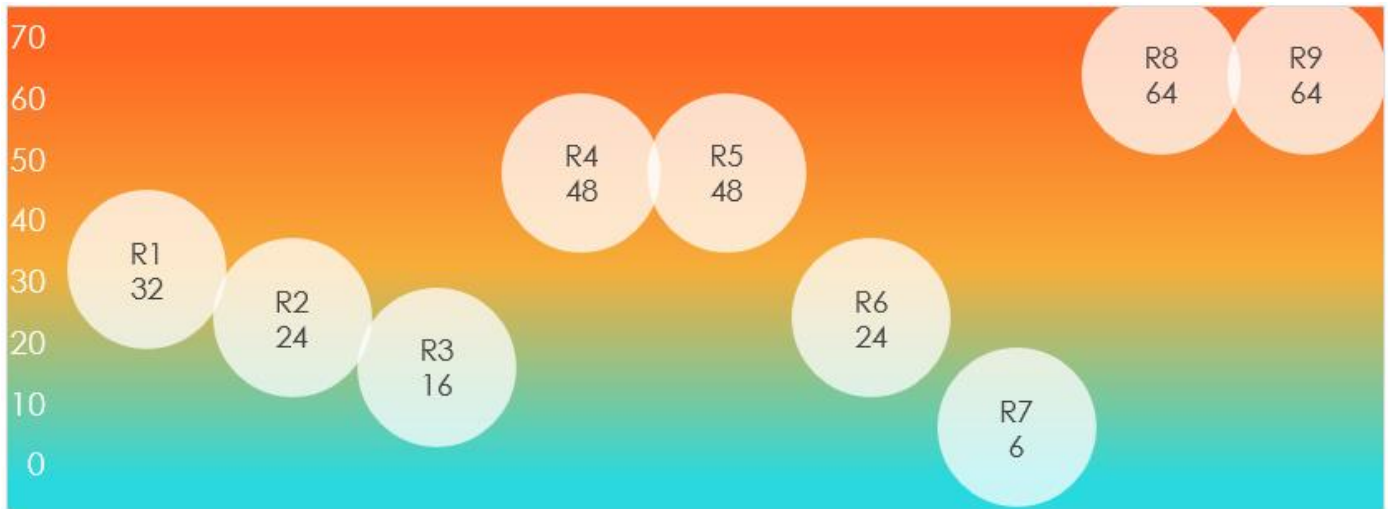
Figure 2. ERP risk severity mapping

Table 4. Case processing summary

		N	Percent
Sample	Training	59	69.40%
	Testing	26	30.60%
Valid		85	100.00%
Total		85	

Table 5. Error model

Training	Cross Entropy Error	7.158
	Percent Incorrect Predictions	1.70%
	Stopping Rule Used	1 consecutive step(s) with no decrease in error
	Training Time	0:00:00,05
Testing	Cross Entropy Error	0.246
	Percent Incorrect Predictions	0.00%

Lastly, the risk of "inadequate support" from the ERP vendor or service provider is a significant concern. Businesses require ongoing support for troubleshooting, updates, and addressing issues that may arise post-implementation. Inadequate support can impede the effective utilization of the ERP system, hindering its ability to meet business objectives. Ensuring a robust support framework is in place is crucial for businesses to navigate challenges and maximize the benefits of their ERP investment. In summary, considering and mitigating these risks is pivotal for a successful ERP adoption, ensuring a smoother transition and long-term effectiveness of the implemented system.

The Table 4 indicates that the research sample consists of 85 Small and Medium-sized Enterprise (SME) owners who have adopted ERP, and the analysis was conducted using a neural network approach. Notably, the results from this analysis reveal an impressively low rate of incorrect predictions, standing at only 1.7%. This remarkably low error rate signifies the accuracy of the neural network model in predicting outcomes related to ERP adoption within the SME context.

Table 5 indicates that the minimal 1.7% incorrect prediction rate suggests a high level of reliability and precision in the neural network's ability to analyze and forecast various aspects of ERP user adoption. Such a low error percentage is indicative of the effectiveness of the neural network in capturing and understanding the nuanced patterns and variables influencing the decisions and behaviors of SME owners in the context of ERP implementation.

Given the robust performance of the neural network analysis, there is a notable expectation that the testing results can significantly contribute to the field of risk management in the context of ERP user adoption. The precision of the model implies that the insights derived from this analysis can be considered trustworthy and valuable for understanding and managing potential risks associated with the adoption of ERP systems among SMEs.

The implications extend to providing SME owners, researchers, and industry practitioners with valuable insights into potential challenges and opportunities related to ERP implementation. By leveraging the accurate predictions from the neural network analysis, organizations can enhance their risk management strategies, making informed decisions that foster a smoother and more successful adoption of ERP systems. Ultimately, the low rate of incorrect predictions reinforces the credibility of the testing results and positions them as a reliable foundation for shaping risk management approaches in the dynamic landscape of ERP user adoption within the SME sector.

Adopting an ERP system is a significant undertaking for organizations aiming to enhance their operational efficiency and decision-making processes. One of the critical factors influencing user satisfaction in the ERP context is the availability of adequate support. Users rely on timely and effective assistance when they encounter challenges or require clarification on system functionalities. This support extends beyond just technical issues to encompass training and guidance on how to maximize the system's capabilities. However, the research indicates that user satisfaction in this regard is not always met. In some instances, organizations may struggle to provide the necessary support due to limited resources, including skilled personnel and comprehensive documentation. The absence of a robust support system can lead to user frustration, negatively impacting the overall perception of the ERP system.

Another crucial aspect influencing user satisfaction is the occurrence of system downtime. Users expect a reliable and consistently available ERP system to carry out their daily tasks seamlessly. The research findings, however, suggest that this

expectation is not universally met, with instances of downtime being a source of discontent among users. Downtime can disrupt operations, result in productivity losses, and contribute to a diminished perception of the ERP system's reliability.

Data security is a paramount concern for organizations implementing ERP systems, as these systems typically store and manage sensitive business information. Users expect a high level of data security to protect confidential information from unauthorized access, breaches, or loss [25]. The research reveals that, despite advancements in ERP security measures, user satisfaction in this area remains a challenge. Instances of data breaches, whether real or perceived, can erode trust in the ERP system, leading to dissatisfaction and concerns about the system's overall integrity.

Perceived ease of use is another critical factor influencing user satisfaction. Users expect ERP systems to be intuitive and user-friendly, facilitating a smooth adoption process. However, the research indicates that many ERP systems still fall short of meeting user expectations in terms of ease of use. Complex interfaces, steep learning curves, and a lack of user-friendly features contribute to dissatisfaction among users, hindering the system's successful implementation. While ERP systems hold the promise of improved organizational efficiency, user satisfaction is often compromised due to challenges in providing adequate support, minimizing system downtime, ensuring robust data security, and enhancing the perceived ease of use. These factors are not only sources of dissatisfaction but also represent significant risks that organizations must address to realize the full potential of their ERP investments.

ERP systems are often acquired from external vendors, making the stability and financial health of these vendors a critical concern for organizations. The explanation lies in the fact that these vendors provide not just the initial implementation but ongoing support, updates, and maintenance. If a vendor encounters financial instability or goes out of business, it can pose a serious risk to the organizations relying on their ERP solutions [2]. The repercussions include potential disruptions in essential services, lack of necessary updates, and a compromised long-term viability of the ERP system. Organizations must thoroughly assess the financial stability of ERP vendors to mitigate this risk and ensure a sustainable partnership.

Another significant risk in ERP adoption revolves around data security. ERP systems house a vast amount of sensitive business data, ranging from financial records and customer information to operational details. Inadequate data security measures expose organizations to the risk of data breaches, unauthorized access, and theft. The explanation lies in the potential consequences of a security breach, including financial losses, regulatory penalties, erosion of customer trust, and damage to the organization's reputation [24]. To address this risk, organizations must implement robust security protocols, encryption measures, and continuous monitoring to safeguard their critical business data.

The interconnected nature of ERP systems across various departments makes system downtime a substantial risk. ERP systems play a central role in coordinating and streamlining business processes, and any significant interruption can lead to disruptions in daily operations. The explanation for this risk lies in the potential impact on productivity, customer service, and overall business efficiency. Extended periods of system downtime can result in delayed decision-making, hindered communication, and financial losses [2]. To mitigate this risk,

organizations must implement strategies such as redundancy measures, robust disaster recovery plans, and regular system maintenance to minimize the chances of extended downtime and its associated negative consequences.

Inadequate support from ERP vendors or service providers is a persistent risk in ERP adoption. The explanation for this risk lies in the reliance on external entities for ongoing support, troubleshooting, and updates. If organizations do not receive timely and effective support, it can lead to operational inefficiencies, unresolved issues, and hindered system optimization. The risk includes the potential frustration of users, prolonged system issues, and a lack of responsiveness to emerging challenges [19]. To address this risk, organizations should carefully evaluate the support mechanisms offered by ERP vendors, ensuring they have access to responsive and knowledgeable support teams throughout the entire lifecycle of the ERP system [26]. The finding from this research contribute to ERP risk management research literature, especially the ones that focus on SMEs. In general, the findings in line with prior research [7, 16], the results identify several key factors that could affect ERP implementation in SMEs, such as vendor stability, data security, and system downtime. However, our research provides deeper knowledge as we examine the adoption of ERP risk management for SMEs, where they potentially have higher risk factors compared to larger enterprises due to lack of resource. Moreover, prior research mostly used qualitative ERP assessments method [15, 27], the research explored the research question using quantitative approaches which could help us predict the succession of ERP adoption in SMEs. Lastly, our research helps to fill the gaps by providing result of that represent the ERP adoption for SMEs, which quite different with that previous research regularly focused on (i.e. larger companies) [28].

Digitalization is a 'must' in this era, especially when businesses like SMEs want to accelerate their businesses globally [29]. This study provides SMEs with clear view on how to identify and measure risks that potentially occurred in the digitalization process. Furthermore, this study also can unify a wide array of SMEs business owners that comes from different level of academics to be able to understand on identifying, measuring and analyzing risks in resource planning. In other word plural kind of SMEs activist can practice more thorough risks management in logic and simple ways. This study also attempts to spread ERP adoption more widely throughout SMEs, since after the pandemic the business ecosystems are significantly change drastically, and this study will assist new or existing SMEs to have more in-depth understanding on how to analyse risks and reduce severe impact on the businesses. This research also emphasises importance of risks management in SMEs, since common risks management is on financial basis, this study highlights on how non-financial risks can have impact in business survivability and performance, at least it will awaken SMEs businesses' people to be more aware that risks do exist, and need to be managed.

5. CONCLUSIONS

ERP adoption is widely utilized, particularly among SMEs. Risks arise when users adopt ERP in their business operations. The research identified several common factors and the most significant risks associated with ERP adoption. The research

results underscore persistent and critical challenges related to ERP adoption, highlighting vendor stability, data security, system downtime, and inadequate support as the primary risks. The findings emphasize the ongoing importance of these key factors in shaping the landscape of ERP implementation for organizations. While the result from this provide insight into ERP risk management in SME, there are some limitations on it. The study has yet to analyze the difference of ERP adoption in different SMEs sectors. Businesses in different industries may face idiosyncratic risk than the others that could affect the success of ERP implementation in one industry but failed in others. The difference may stem from different regulation, variations in IT infrastructure and difference in resource and technical capabilities. We highly recommend that future research could examines ERP adoption risks across different industries as well as different business size. By incorporate that factor, it will lead to more comprehensive understanding of ERP risk management through diverse business environments.

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