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Identifying Key Factors Influencing Technology Roadmapping in Enterprise Resource Planning (ERP) Systems: A Framework for Successful Organizational Implementation

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ABSTRACT

This study aims to identify and rank the key factors influencing the development of Technology Roadmapping (TRM) in information management for Enterprise Resource Planning (ERP) systems across large and small organizations, with particular emphasis on Small and Medium-sized Enterprises (SMEs). The study seeks to propose a comprehensive and flexible framework to mitigate ERP implementation risks, strengthen strategic alignment, enhance organizational performance, and facilitate digital transformation. Furthermore, the provision of actionable guidance for managers regarding resource allocation and the mitigation of ERP implementation challenges constitutes a central objective of this research. The research adopts a quantitative, descriptive-analytical approach. Data were extracted from 70 authoritative scientific sources and analyzed through qualitative content analysis, through which seven key factors were identified: Organizational Readiness, Top Management Support, Information Technology (IT) Infrastructure, ERP System Quality, Critical Success Factors (CSFs), Project Management, and Change Management. Factor prioritization was conducted using the CODAS method within a Multi-criteria decision-making (MCDM) framework combined with Fuzzy evaluation, thereby enhancing analytical precision. The findings demonstrate that Organizational Readiness and IT Infrastructure, with a joint score of 0.956, constitute the most critical factors in ERP Technology Roadmapping. Subsequently, Top Management Support, Critical Success Factors, and Change Management, with a score of 0.522, occupy the second rank, while ERP System Quality and Project Management, with a score of 0.000, are positioned in the third rank. The proposed framework demonstrates applicability across diverse organizational contexts and contributes to the reduction of financial and operational risks. By prioritizing key factors, the framework facilitates optimal resource allocation and alleviates ERP implementation challenges. Future research is recommended to investigate emerging technologies, such as cloud-based ERP and artificial intelligence, within the context of ERP Technology Roadmapping.

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Introduction

Enterprise Resource Planning (ERP) systems constitute critical instruments for organizational process integration and the advancement of information management. By synchronizing data across functional units, these systems enhance productivity, transparency, and strategic decision-making (Fui-Hoon Nah et al., 2001). Contemporary organizations increasingly confront persistent and uncertain competitive pressures intensified by technological innovation, dynamic market environments, and evolving customer demands (Asheghi Eskoui & Azari, 2022). Within the global economy, organizations—including large enterprises and Small and Medium-sized Enterprises (SMEs)—rely on ERP systems to manage operational complexity and sustain competitiveness. Despite these advantages, ERP implementation encounters substantial challenges, including high costs, technical risks, and organizational resistance, all threatening project success (Chofreh et al., 2018). Organizational resistance often originates from cultural transformation, insufficient technological skills, inadequate IT infrastructure, and the complexities of project management and interdepartmental coordination (Haddara & Zach, 2011; Motwani, Subramanian, & Gopalakrishna, 2005). Financial and human resource constraints further exacerbate these difficulties, while the literature consistently reports persistently high ERP project failure rates (Chofreh et al., 2018). ERP Technology Roadmapping (TRM) supports organizations in strategic planning and resource prioritization by identifying success-enabling factors and clarifying implementation pathways (Keshavarz Ghorabaei et al., 2015). As core components of information management, ERP systems play a decisive role in productivity enhancement, process coherence, and decision-quality improvement. Nevertheless, the absence of comprehensive frameworks has contributed to implementation failures and increased organizational demand for structured guidance to overcome technical and organizational challenges. Existing literature predominantly emphasizes large organizations in developed economies, while the specific requirements of SMEs and developing regions, particularly under heterogeneous contextual conditions, remain insufficiently addressed (Chofreh et al., 2018; Schniederjans & Yadav, 2013). Each organization operates within a unique configuration of structure, resources, and strategic objectives, rendering rigid frameworks largely inadequate. Consequently, the necessity of this study lies in the development of a flexible framework capable of reducing implementation risks and ensuring applicability across globally diverse organizational settings. Accordingly, the primary objective of this research is the identification and ranking of key factors influencing the development of Technology Roadmapping in ERP information management. Prior studies underscore that the identification and prioritization of Critical Success Factors within organizations are essential to implementation success (Zahedi & Hosseini Sarkhosh, 2025). By designing an adaptive framework, this study seeks to reduce execution risks, improve resource allocation, and enhance strategic decision-making. The findings not only contribute to theoretical advancement in the ERP domain but also support organizations in designing context-sensitive and customized solutions for successful ERP implementation across diverse operational scales and environments.

Research Background

The review of prior research examines seminal studies on Enterprise Resource Planning (ERP) implementation and the factors influencing its TRM. As outlined in the introduction, the primary objective involves the identification of challenges and success factors relevant to both large organizations and SMEs at the organizational level. By synthesizing the objectives and findings of previous studies, this section establishes a comprehensive analytical foundation. The selected studies elucidate existing gaps in the literature (Chofreh et al., 2018). Consequently, this review informs the development of a flexible and practical roadmap applicable across diverse organizational contexts. Fui-Hoon Nah et al. (2001) investigated Critical Success Factors in ERP implementation through qualitative analysis, examining factors such as Organizational Readiness and Top Management Support. Their findings demonstrate that Organizational Readiness, through the reinforcement of an acceptance-oriented culture, reduces implementation failure risks, while Top Management Support ensures strategic

alignment. These factors remain essential across globally diverse organizations. Haddara and Zach (2011) conducted a literature review to examine ERP implementation challenges in SMEs, analyzing organizational and financial barriers. The findings indicate that employee resistance, primarily attributable to insufficient training, constitutes the principal challenge; however, Organizational Readiness supported by targeted training programs mitigates such resistance. These insights hold particular relevance for smaller organizations operating in global markets. Motwani et al. (2005) analyzed ERP success factors through case studies, emphasizing the role of Top Management Support and interdepartmental coordination. Their findings reveal that Top Management Support enhances resource allocation, whereas its absence frequently results in project failure. This study provides practical guidance for organizations characterized by complex structural arrangements. Chofreh et al. (2018) proposed a framework for sustainable ERP implementation through Technology Roadmapping, with a specific focus on IT Infrastructure. The results indicate that robust IT Infrastructure enhances ERP performance, while infrastructural deficiencies contribute to system disruptions. This framework supports ERP planning in globally operating organizations. Aladwani (2001) examined Change Management strategies for ERP success, with particular emphasis on user acceptance. The findings demonstrate that training and communication programs reduce user resistance, thereby strengthening system acceptance. Change Management consequently plays a critical role in organizations facing cultural challenges. Schniederjans and Yadav (2013) proposed an integrated model for ERP implementation by examining success factors, with an emphasis on critical elements such as vendor selection. Their findings suggest that vendor coordination poses a significant challenge for SMEs, particularly during execution phases, and the study provides targeted guidance for smaller organizations. Seethamraju (2015) analyzed cloud ERP adoption in SMEs, focusing on ERP System Quality and cost considerations. The findings indicate that high-quality systems enhance productivity, while cloud-based ERP reduces costs for SMEs. These outcomes are particularly relevant for resource-constrained organizations operating globally. Davenport (1998) presented a conceptual framework analyzing the impact of ERP on business process reengineering, with an emphasis on Technology Roadmapping. The findings demonstrate that ERP improves organizational performance through process integration, while Technology Roadmapping facilitates strategic alignment. This framework offers value for organizations across implementation contexts. Butarbutar et al. (2023) identified Critical Success Factors in the post-implementation phase of ERP through a systematic literature review. Their findings indicate that continuous training and technical support enhance ERP productivity, while post-implementation Change Management reduces user resistance. These insights support global organizations during the operational phase of ERP systems. Gessa et al. (2023) conducted a qualitative study examining ERP adoption in SMEs under crisis conditions, such as the COVID-19 pandemic. Their analysis demonstrates that system flexibility and Top Management Support are critical under turbulent conditions, while cloud ERP reduces costs for SMEs. This study provides practical guidance for small organizations operating in unstable environments.

Research Methodology

This study adopts a quantitative, descriptive-analytical approach. Data were extracted from 70 authoritative scientific sources, and qualitative content analysis enabled the identification of seven key factors. To ensure systematic source selection, the Kitchenham and Charters' (2007) systematic review protocol was applied. This framework structures the research process into sequential phases, and the source selection and research procedures followed its six primary stages. Figure 1 illustrates the overall structure of this process. Source identification was conducted across leading English-language scientific databases, including ScienceDirect, Scopus, Web of Science, PubMed, IEEE, and Google Scholar, using the keywords "Roadmap," "ERP Roadmap," and "Technology Roadmapping in ERP." Inclusion criteria emphasized ERP success factors in large organizations and SMEs, alongside the application of quantitative and qualitative research methods. Sources were filtered based on the keywords "Roadmap" and "ERP" within English-language publications and questionnaire- or interview-based methodologies. Ultimately, 70 sources aligned with the research objectives were selected for detailed review and analysis, as presented in Table 1.

Figure 1) Source Selection Process and Research Methodology Based on the Six Main Stages of Kitchenham and Charters' (2007) Research

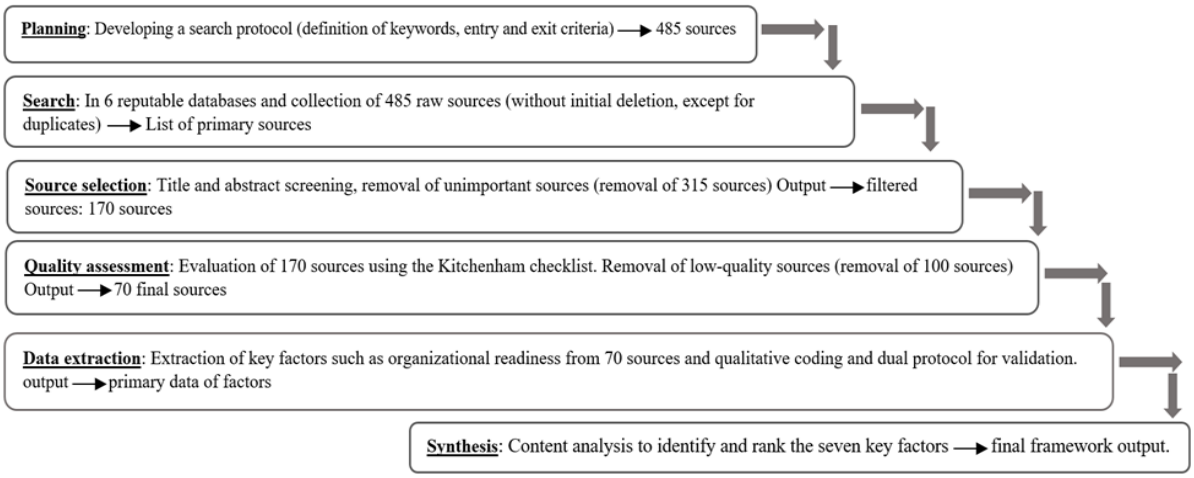


Table 1) Sources Reviewed in the Present Study

Hypothesis Confirmation/Rejection	Hypothesis/Research Question	Source Type	Variables (Independent/Dependent)	Author(s)
Confirmed	Hypothesis: Project Management practices and Organizational Readiness improve ERP implementation success.	Literature	Independent: Project Management practices; Organizational Readiness. Dependent: ERP implementation success.	Supramaniam & Kuppusamy (2010)
—	Research question: How do technology infrastructure and management support influence ERP adoption in SMEs? Result: Both factors exert positive effects.	Research question	Independent: technology infrastructure; management support. Dependent: ERP adoption in Indonesian SMEs.	Saputro et al. (2010)
Confirmed	Hypothesis: SaaS technology reduces costs and increases ERP adoption.	Literature	Independent: SaaS technology; implementation costs. Dependent: SaaS-based ERP adoption in SMEs.	Seethamraju (2015)
Confirmed	Hypothesis: CSFs (Critical Success Factors) lead to ERP implementation success.	Literature	Independent: CSFs; Organizational Readiness. Dependent: ERP implementation success in SMEs.	Kiran & Reddy (2019)
Confirmed	Hypothesis: Successful utilization of ERP systems exerts a positive and direct effect on organizational business performance improvement.	Research question	Independent: strategic use of information technology; appropriate ERP system selection. Dependent: ERP system utilization; business performance.	Gërvalla (2021)

—	Research question: How do implementation challenges affect ERP success? Result: Skills and challenge management are critical.	Research question	Independent: implementation challenges; workforce skills. Dependent: ERP implementation success.	AlMuhayfith & Shaiti (2020)
Confirmed	Hypothesis: Risk reduction leads to ERP implementation success.	Literature	Independent: implementation risks; firm size. Dependent: ERP implementation success in SMEs.	Poba-Nzaou & Raymond (2011)
Confirmed	Hypothesis: decision-support systems improve ERP implementation.	Literature	Independent: decision-support systems; technology infrastructure. Dependent: ERP implementation success in medium-sized businesses.	Alizai (2014)
—	Research question: How do organizational factors influence ERP success? Result: Organizational factors are key.	Research question	Independent: organizational factors; implementation processes. Dependent: ERP success in SMEs.	Haddara & Zach (2011)
Confirmed	Hypothesis: technology infrastructure leads to ERP success.	Literature	Independent: technology infrastructure. Dependent: ERP success.	Dezdar & Ainin (2011)
Confirmed	Hypothesis: technology infrastructure increases ERP adoption.	Literature	Independent: adoption factors; technology infrastructure. Dependent: ERP adoption in SMEs.	Chang et al. (2012)
—	Research question: How do ERP technologies influence information integration? Result: Technologies improve integration.	Research question	Independent: ERP technologies; business processes. Dependent: information systems integration.	Nazemi et al. (2012)
Confirmed	Hypothesis: management support and training lead to ERP success.	Literature	Independent: management support; employee training. Dependent: ERP implementation success.	Amini & Sadat Safavi (2013)
Confirmed	Hypothesis: ERP implementation motivations significantly influence implementation success in public organizations.	Research question	Independent: ERP implementation motivations. Dependent: ERP implementation success in e-government.	Raymond et al. (2006)
Confirmed	Hypothesis: software quality improves ERP readiness.	Literature	Independent: software quality; costs. Dependent: readiness for ERP adoption.	Razmi et al. (2009)
Confirmed	Hypothesis: Organizational Readiness leads to ERP success.	Literature	Independent: Organizational Readiness; implementation processes. Dependent: ERP project success.	Kirmizi & Kocaoglu (2021)

Confirmed	Hypothesis: critical decision-making leads to ERP success.	Literature	Independent: critical decision-making; firm size. Dependent: ERP integration in SMEs.	Malhotra & Temponi (2010)
Confirmed	Hypothesis: Organizational Readiness leads to ERP success.	Literature	Independent: Organizational Readiness; business processes. Dependent: ERP implementation success.	Zaied & Mohmed (2020)
Confirmed	Hypothesis: system support improves ERP efficiency.	Literature	Independent: system support; employee skills. Dependent: ERP system efficiency.	Wognum et al. (2004)
Confirmed	Hypothesis: organizational culture and technology infrastructure improve ERP adoption.	Literature	Independent: organizational culture; technology infrastructure. Dependent: ERP adoption.	Bueno & Salmeron (2008)
Confirmed	Hypothesis: management support improves ERP performance.	Literature	Independent: business processes; management support. Dependent: ERP system performance.	Al-Mashari et al. (2003)
—	Research question: How does ERP technology influence cost reduction? Result: ERP reduces costs.	Research question	Independent: labor substitution; ERP technology. Dependent: operational cost reduction.	Chuang & Shaw (2005)
Confirmed	Hypothesis: project team skills lead to ERP success.	Literature	Independent: project team skills; management support. Dependent: ERP implementation success.	Nandhakumar (1996)
—	Research question: How does user experience influence ERP success? Result: User experience is critical.	Research question	Independent: user experience; SAP technology. Dependent: ERP implementation success.	Grube (2018)
Confirmed	Hypothesis: customer support leads to ERP success.	Literature	Independent: customer support; system strategy. Dependent: ERP system success.	Reich & Benbasat (1990)
Confirmed	Hypothesis: Organizational Readiness increases ERP project effectiveness.	Literature	Independent: Organizational Readiness. Dependent: ERP implementation improvement.	Jagoda & Samaranayake (2017)
Confirmed	Hypothesis: system design improves ERP efficiency.	Literature	Independent: sustainable ERP system use; system design. Dependent: ERP efficiency.	Chofreh et al. (2016)
Confirmed	Hypothesis: understanding factors influencing ERP implementation success increases ERP success.	Literature	Independent: critical factors influencing ERP implementation success. Dependent: ERP implementation success.	Motwani, Akbulut, & Nidumolu (2005)

Confirmed	Hypothesis: emerging technologies (e.g., blockchain) improve ERP adoption.	Literature	Independent: emerging technologies. Dependent: ERP adoption.	Shaul & Tauber (2013)
Confirmed	Hypothesis: technology infrastructure improves ERP efficiency.	Literature	Independent: technology infrastructure. Dependent: ERP efficiency.	Law & Ngai (2007)
—	Research question: How do ERP II frameworks affect efficiency? Result: Frameworks improve efficiency.	Research question	Independent: ERP II frameworks; technology integration. Dependent: enterprise information systems efficiency.	Möller (2005)
Confirmed	Hypothesis: data security leads to ERP success.	Literature	Independent: data security; implementation challenges. Dependent: ERP implementation success.	Morrisson (2020)
Confirmed	Hypothesis: decision-support systems lead to ERP success.	Literature	Independent: integrated decision-support systems; technology infrastructure. Dependent: ERP implementation success.	Xie et al. (2014)
Confirmed	Hypothesis: software quality leads to successful ERP selection.	Literature	Independent: software quality; cost constraints. Dependent: successful ERP selection.	Onut & Efendigil (2010)
Confirmed	Hypothesis: green practices improve ERP performance.	Literature	Independent: ERP technology; green supply chain management practices. Dependent: ERP performance.	Santoso et al. (2022)
Confirmed	Hypothesis: process management leads to ERP success.	Literature	Independent: business process management; CSFs. Dependent: ERP implementation success.	Žabjek et al. (2009)
Confirmed	Hypothesis: ERP integration improves efficiency.	Literature	Independent: ERP integration; supply chain management. Dependent: information systems efficiency.	Su & Yang (2010)
Confirmed	Hypothesis: ERP technology improves agility.	Literature	Independent: ERP technology; supply chain agility. Dependent: adaptability in the automotive industry.	Jayender & Kundu (2021)
Confirmed	Hypothesis: sustainability improves ERP efficiency.	Literature	Independent: sustainability; ERP technology. Dependent: sustainable information systems efficiency.	De Soete (2016)
Confirmed	Hypothesis: technology infrastructure improves ERP efficiency.	Literature	Independent: technology infrastructure. Dependent: ERP efficiency.	Doom et al. (2010)

—	Research question: How does Organizational Readiness influence cloud ERP adoption? Result: Organizational Readiness is key.	Research question	Independent: Organizational Readiness; cloud technology. Dependent: cloud-based ERP adoption.	Al-Ghofaili & Al-Mashari (2014)
Confirmed	Research question: Benefits management (BM) significantly contributes to sustainable value realization from ERP systems.	Research question	Independent: ERP system implementation. Dependent: sustainable value realization from ERP systems.	Anaya et al. (2023)
—	Research question: How does AI adoption influence ERP efficiency? Result: AI adoption improves efficiency.	Research question	Independent: AI adoption; technology infrastructure. Dependent: AI-enabled ERP system efficiency.	Singh et al. (2023)
Confirmed	Hypothesis: technology infrastructure enables digital ERP adoption.	Literature	Independent: digital innovations; technology infrastructure. Dependent: digital ERP adoption.	Mick et al. (2024)
Confirmed	Hypothesis: organizational culture improves decision-making in ERP.	Literature	Independent: data-driven technologies; organizational culture. Dependent: data-driven decision-making in ERP.	Gupta & Kohli (2006)
—	Research question: Which factors influence ERP adoption in education? Result: Organizational Readiness is key.	Research question	Independent: ERP technologies; Organizational Readiness. Dependent: ERP adoption in educational information management.	Gonugunta & Leo (2024)
Confirmed	Hypothesis: blockchain technology improves ERP data interoperability among supply chain stakeholders, increasing trust and system adoption.	Literature	Independent: blockchain technology; stakeholder trust. Dependent: ERP adoption and data interoperability in supply chain information management.	Bhujade et al. (2021)
Confirmed	Hypothesis: blockchain technology improves ERP data interoperability.	Literature	Independent: blockchain technology; trust. Dependent: ERP adoption.	Malamas et al. (2023)
—	Hypothesis: technology infrastructures enable smart ERP adoption.	Literature	Independent: smart ERP technologies; technology infrastructures. Dependent: ERP adoption in health information management.	Pohrib et al. (2025)
—	Hypothesis: CSFs lead to ERP implementation success.	Literature	Independent: CSFs; implementation processes. Dependent: ERP implementation success.	Esteves & Pastor (2001)

Confirmed	Hypothesis: user training and management support lead to ERP success.	Literature	Independent: user training; management support. Dependent: ERP implementation success.	Umble et al. (2003)
Confirmed	Hypothesis: Organizational Readiness and organizational culture change lead to ERP success.	Literature	Independent: Organizational Readiness; organizational culture change. Dependent: ERP implementation success.	Motwani, Subramanian, & Gopalakrishna (2005)
Confirmed	Hypothesis: management support leads to ERP success.	Literature	Independent: CSFs; management support. Dependent: ERP implementation success.	Fui-Hoon Nah et al. (2001)
Confirmed	Hypothesis: organizational fit leads to ERP success.	Literature	Independent: organizational fit; business processes. Dependent: ERP implementation success.	Hong & Kim (2002)
Confirmed	Hypothesis: digital transformation technologies improve ERP efficiency.	Literature	Independent: digital transformation technologies. Dependent: ERP efficiency.	Ahmad & Cuenca (2013)
Confirmed	Hypothesis: process reengineering leads to ERP success.	Literature	Independent: business processes; organizational benefits. Dependent: ERP system success.	Shang & Seddon (2002)
—	Research question: How does user resistance influence ERP adoption? Result: Change strategies improve adoption.	Research question	Independent: user resistance; change strategies. Dependent: ERP adoption.	Aladwani (2001)
Confirmed	Hypothesis: system quality and information quality lead to ERP success.	Literature	Independent: system quality; information quality. Dependent: ERP implementation success.	Maditinos et al. (2011)
Confirmed	Hypothesis: CSFs lead to ERP success.	Literature	Independent: CSFs; Organizational Readiness. Dependent: ERP implementation success.	Dezdar & Ainin (2009)
Confirmed	Hypothesis: vendor support leads to ERP success.	Literature	Independent: system quality; vendor support. Dependent: ERP success in SMEs.	Ifinedo & Nahar (2009)
Confirmed	Hypothesis: supply chain coordination improves ERP efficiency.	Literature	Independent: ERP technologies; supply chain coordination. Dependent: ERP efficiency in manufacturing industries.	Pan et al. (2011)
Confirmed	Hypothesis: technology infrastructure and Organizational Readiness improve ERP adoption.	Literature	Independent: technology infrastructure; Organizational Readiness. Dependent: ERP adoption.	Bradley & Lee (2009)

Confirmed	Hypothesis: cloud technology reduces costs and increases ERP adoption.	Literature	Independent: cloud technology; implementation costs. Dependent: cloud-based ERP adoption in SMEs.	Schniederjans & Yadav (2013)
Confirmed	Hypothesis: employee training and technology infrastructure improve ERP success.	Literature	Independent: employee training; technology infrastructure. Dependent: ERP success.	Velcu (2010)
Confirmed	Hypothesis: supply chain integration leads to ERP success.	Literature	Independent: supply chain management; ERP technology. Dependent: ERP success in manufacturing industries.	van Hoek et al. (2006)
Confirmed	Hypothesis: ERP technologies improve system efficiency.	Literature	Independent: ERP technologies. Dependent: ERP efficiency.	Huang & Palvia (2001)
Confirmed	Hypothesis: antecedent factors lead to ERP implementation success in achieving competitive advantage.	Research question	Independent: antecedent factors; Organizational Readiness. Dependent: competitive advantage achievement through ERP implementation.	Ram et al. (2014)
Confirmed	Hypothesis: organizational culture and technology infrastructure improve ERP adoption.	Literature	Independent: organizational culture; technology infrastructure. Dependent: ERP adoption.	Butarbutar et al. (2023)
Confirmed	Hypothesis: Internet of Things (IoT) technologies improve ERP efficiency.	Literature	Independent: IoT technologies; ERP integration. Dependent: ERP system efficiency.	Addo-Tenkorang & Helo (2016)
Confirmed	Hypothesis: Organizational Readiness improves ERP adoption.	Literature	Independent: Organizational Readiness. Dependent: ERP adoption.	Upadhyay & Dan (2009)

By analyzing the sources listed in Table 1 (70 sources) and focusing on the independent and dependent variables, hypotheses, and research questions, the factors influencing Technology Roadmapping (TRM) in Enterprise Resource Planning (ERP) systems were identified. Factor extraction was conducted from the abstracts, methodology sections, and reported findings of the selected sources. Subsequently, the factors were classified into overarching categories, as presented in Table 2. Furthermore, a consolidated list of factors influencing Technology Roadmapping in ERP systems was compiled based on the literature review and expert viewpoints reported in the form of questionnaires and interviews within the available sources. This procedure enabled the identification of the most frequently cited factors from the expert perspective, as reported in Table 3.

Table 2) List of Identified Factors Influencing Technology Roadmapping in Enterprise Resource Planning (ERP) Systems

Factor Category	Constituent Factors
Organizational Factors	Organizational Readiness Organizational Culture Top Management Support

	Employee Training User Resistance Organizational Fit with Enterprise Resource Planning (ERP)
Technological Factors	IT Infrastructure ERP System Quality Information Quality Emerging Technologies (Artificial Intelligence, Internet of Things, Blockchain) System Integration Cloud Technology
Managerial and Process Factors	Critical Success Factors (CSFs) Business Process Management Project Management Change Management Supply Chain Coordination
External Factors	Innovation Policies Cost Constraints Vendor Support Legal and Regulatory Requirements
Environmental and Industry Factors	Firm Size Industry Type Sustainability Considerations Market Competition

Table 3) List of Identified Factors Influencing Technology Roadmapping in Enterprise Resource Planning Systems, Extracted from Expert Interviews and Questionnaires

Factor Description	Identified Factors from Experts' Perspectives (Extracted from Sources)
Key prerequisite for ERP Technology Roadmapping (TRM)	Organizational Readiness
Critical factor for Technology Roadmapping success	Top Management Support
Technological foundation of Technology Roadmapping	IT Infrastructure
Key factor for overcoming user resistance	Change Management
Most frequently cited in qualitative and quantitative studies	Critical Success Factors (CSFs)

Subsequently, a significance threshold guided the selection of high-importance factors. Factors cited in more than 30% of the sources (at least 21 out of 70), or prominently emphasized in interviews and questionnaires, qualified for inclusion. The analysis examined the number of sources associated with each factor, as reported in Table 4. Consequently, factors meeting the significance threshold—either exceeding 30% source coverage or demonstrating prominence in interviews and questionnaires—advanced to the subsequent analytical stage. Moreover, factors prominently emphasized in interviews and questionnaires (e.g., Change Management) were retained despite marginally falling below the quantitative threshold, given their qualitative salience. Conversely, factors such as Emerging Technologies (10 sources, 14.3%) and Sustainability (11 sources, 15.7%) were excluded due to low recurrence or limited prominence in expert elicitation. Similarly, environmental factors, such as Market Competition (7 sources, 10.0%), were omitted because of their indirect influence. The final set of selected factors is presented in Table 5.

Table 4) Determination of the Significance Threshold for Selecting Influential Factors

Factor	Number of Relevant Sources	Percentage of Sources	Mention in Interviews/Questionnaires	Selected for Analysis
Organizational Readiness	32	45.7%	Yes (Prominent)	Yes
Organizational Culture	18	25.7%	No	No
Top Management Support	28	40.0%	Yes (Prominent)	Yes
Employee Training	20	28.6%	No	No
User Resistance	12	17.1%	No	No
Organizational Fit	15	21.4%	No	No
IT Infrastructure	30	42.9%	Yes (Prominent)	Yes
ERP System Quality	22	31.4%	No	Yes
Information Quality	16	22.9%	No	No
Emerging Technologies	10	14.3%	No	No
System Integration	19	27.1%	No	No
Cloud Technology	14	20.0%	No	No
Critical Success Factors (CSFs)	26	37.1%	Yes (Prominent)	Yes
Business Process Management	17	24.3%	No	No
Project Management	21	30.0%	No	Yes
Change Management	23	32.9%	Yes (Prominent)	Yes
Supply Chain Coordination	13	18.6%	No	No
Innovation Policies	15	21.4%	No	No
Cost Constraints	12	17.1%	No	No
Vendor Support	14	20.0%	No	No
Legal and Regulatory Requirements	8	11.4%	No	No
Firm Size	10	14.3%	No	No
Industry Type	9	12.9%	No	No
Sustainability Considerations	11	15.7%	No	No
Market Competition	7	10.0%	No	No

Table 5) Selected Influential Factors Based on the Defined Significance Threshold

Factor	Factor Description	Sources	Frequency in Sources
Organizational Readiness	Key prerequisite for ERP Technology Roadmapping	32 sources and interviews	45.7% (32 sources)
Top Management Support	Critical factor for resource allocation and Technology Roadmapping guidance	28 sources and questionnaires	40.0% (28 sources)
IT Infrastructure	Technological foundation for ERP implementation	30 sources and interviews	42.9% (30 sources)
ERP System Quality	Influential on system performance and acceptance	22 sources	31.4% (22 sources)
Critical Success Factors (CSFs)	Set of key factors for Technology Roadmapping success	26 sources and interviews	37.1% (26 sources)

Project Management	Significant role in Technology Roadmapping planning and execution	21 sources	30.0% (21 sources)
Change Management	Mechanism for overcoming resistance and facilitating adoption	23 sources and interviews	32.9% (23 sources)

Subsequently, the CODAS method was employed to rank the factors influencing Technology Roadmapping (TRM) in ERP systems. The Fuzzy CODAS method, as an advanced Multi-criteria decision-making (MCDM) technique, constitutes an integral component of the soft computing paradigm, encompassing tools such as fuzzy logic and intelligent systems for managing uncertainty and the inherent complexity of qualitative–quantitative data. Grounded in fuzzy Euclidean and Taxicab distance computations using Triangular Fuzzy Numbers (TFNs), this method enables the simulation of nonlinear decision behaviors under ambiguous conditions. Compared with classical approaches, such as the Analytic Hierarchy Process (AHP), the Fuzzy CODAS method demonstrates notable advantages, including greater flexibility in addressing interdependencies among criteria and linguistic uncertainty, without imposing preference independence assumptions. Consequently, this capability yields higher ranking accuracy, exemplified by the score of 0.956 for Organizational Readiness. These characteristics render the Fuzzy CODAS method which is particularly suitable for ERP-related analyses in dynamic environments. Within this framework, the factors influencing Technology Roadmapping in ERP information management, previously selected in the preceding phase (Table 5), underwent valuation using a fuzzy numerical scale. The CODAS method subsequently processed these valuations, enabling the identification and ranking of key factors. The methodological stages are outlined as follows.

Initially, factor valuation relied on Triangular Fuzzy Numbers, given their effectiveness in modeling uncertainty in human judgment. This valuation reflected expert opinions reported in the literature and was informed by both qualitative evidence and approximate weighting based on factor frequency and perceived importance. In essence, the valuation combined frequency of occurrence across 70 sources with qualitative significance derived from expert interviews and questionnaires. To simulate expert judgment, the approximate mean importance of the factors extracted from the literature, presented in Table 6, was calculated.

Table 6) Approximate Mean Importance of Factors Extracted from the Literature

Factor	Code	Factor Description	Frequency in Sources	Linguistic Score
Organizational Readiness	C1	32 sources and interviews	45.7% (32 sources)	Very High (VH)
Top Management Support	C2	28 sources and questionnaires	40.0% (28 sources)	High (H)
IT Infrastructure	C3	30 sources and interviews	42.9% (30 sources)	Very High (VH)
ERP System Quality	C4	22 sources	31.4% (22 sources)	Medium (M)
Critical Success Factors	C5	26 sources and interviews	37.1% (26 sources)	High (H)
Project Management	C6	21 sources	30.0% (21 sources)	Medium (M)
Change Management	C7	23 sources and interviews	32.9% (23 sources)	High (H)

Subsequently, the fuzzy decision matrix for the seven factors (C1–C7), presented in Table 7, was constructed.

Table 7) Fuzzy Decision Matrix for Factors C1–C7

Factor	Linguistic Score	Triangular Fuzzy Number (l, m, u)
C1	VH	(0.75, 1.00, 1.00)
C2	H	(0.50, 0.75, 1.00)
C3	VH	(0.75, 1.00, 1.00)
C4	M	(0.25, 0.50, 0.75)
C5	H	(0.50, 0.75, 1.00)
C6	M	(0.25, 0.50, 0.75)
C7	H	(0.50, 0.75, 1.00)

The CODAS method was then applied to rank the alternatives—here, factors C1–C7—based on Euclidean and Taxicab distances from the negative ideal solution. The seven procedural steps are summarized below.

Step 1. Defuzzification of Fuzzy Numbers

To simplify computation, Triangular Fuzzy Numbers were transformed into crisp values using the weighted mean formula:

$$x = \frac{l+4m+u}{6}$$

Table 8) Crisp Decision Matrix

Factor	Crisp Score
C1	0.958
C2	0.750
C3	0.958
C4	0.500
C5	0.750
C6	0.500
C7	0.750

Step 2. Normalization of the Decision Matrix

Given that all factors represent benefit criteria, linear normalization was applied:

$$r_{ij} = \frac{x_{ij}}{max_i\, x_{ij}}$$

Table 9) Normalized Decision Matrix

Factor	Normalized Score
C1	1.000
C2	0.783
C3	1.000
C4	0.522
C5	0.783
C6	0.522
C7	0.783

Step 3. Weighted Normalized Matrix

Assuming equal weights for all factors $(1 = w_j)$, the weighted normalized matrix equaled the normalized matrix, as $r_{ij} = 1 \cdot r_{ij} = w_j \cdot r_{ij}$.

Step 4. Determination of the Negative Ideal Solution (NIS)

For benefit criteria, the negative ideal solution corresponded to the minimum normalized value:

$$n_i = min_i\, r_{ij}$$

Step 5. Calculation of Euclidean and Taxicab Distances

For each factor, the Euclidean distance E_i and the Taxicab distance T_i from the negative ideal solution were computed as follows:

$$E_i = \sqrt{\sum_i (r_{ij} - n_j)^2}$$

$$T_i = \sum_j |r_{ij} - n_j|$$

Step 6. Construction of the Relative Assessment Matrix

The relative assessment matrix (R_a) was derived by comparing Euclidean and Taxicab distances across factor pairs:

$$R_a(i.k) = (\psi(E_i - E_K) + (E_i - E_k) \cdot (T_i - T_k))$$

Where:

$\psi(x) = 1$ if $|x| \geq$, and $\psi(x) = 0$

otherwise, $\tau = 0.02$.

To simplify, the evaluation score (H_i) for each factor was calculated as the sum of the rows of the relative matrix:

$$H_i = \sum_k R_a(i.k)$$

Instead of calculating the full relative matrix (which requires a pairwise comparison), the weighted sum of Euclidean and taxonomic distances was used:

$$H_i = E_i + T_i$$

Step 7. Ranking of Factors

Factors were ranked in descending order of (H_i), where higher values indicate higher priority.

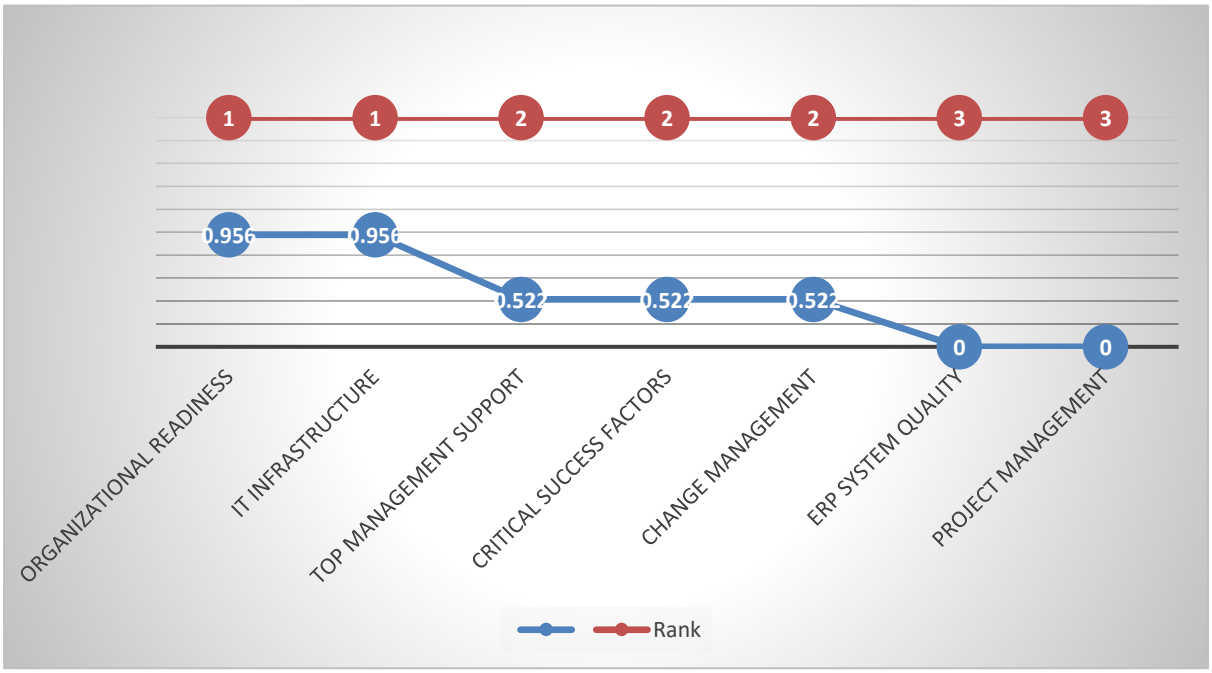
Table 10) Ranking of Factors Influencing Technology Roadmapping in Enterprise Resource Planning (ERP) Systems

Factor	H_i	Rank	Factor Description
C1 (Organizational Readiness)	0.956	1	Critical role in preparing the organization for ERP implementation
C3 (IT Infrastructure)	0.956	1	Technological foundation for Technology Roadmapping success
C2 (Top Management Support)	0.522	2	Essential for resource allocation and strategic guidance
C5 (Critical Success Factors)	0.522	2	Collective impact of key success determinants
C7 (Change Management)	0.522	2	Mechanism for overcoming resistance and facilitating adoption

C4 (ERP System Quality)	0.000	3	Influence on system performance and user acceptance
C6 (Project Management)	0.000	3	Significant role in Technology Roadmapping planning and execution

Although **ERP System Quality (C4)** and **Project Management (C6)** attained Rank 3, indicating comparatively lower priority within this analysis, the findings nonetheless recognize both factors as substantively important. The factor ranking influencing Technology Roadmapping (TRM) in Enterprise Resource Planning (ERP) systems is illustrated in **Figure 1**.

Figure 1) Ranking of Factors Influencing Technology Roadmapping in Enterprise Resource Planning (ERP) Systems



Findings

This study identified seven key factors influencing Technology Roadmapping (TRM) in ERP information management: **Organizational Readiness**, **Top Management Support**, **IT Infrastructure**, **ERP System Quality**, **Critical Success Factors (CSFs)**, **Project Management**, and **Change Management**. These factors emerged from a systematic review of 70 scholarly sources indexed in reputable academic databases, applying a frequency criterion exceeding 30% of the sources. Qualitative content analysis further corroborated factor prominence. The **CODAS method**, operationalized through Euclidean and Taxicab distance calculations, enabled factor ranking, while **Fuzzy evaluation** grounded in the literature informed factor valuation. Collectively, these factors exhibit varying degrees of criticality across organizational contexts. Alignment with prior studies reinforces result validity, and the identification phase establishes a robust foundation for subsequent analyses. **Organizational Readiness** and **IT Infrastructure**, assigned the fuzzy means 0.75, 1, and 1, received a *very high* valuation. **Top Management Support** and **Change Management**, with the means 0.5, 0.75, and 1, attained a *high* valuation. Conversely, **ERP System Quality** and **Project Management**, characterized by the means 0.25, 0.5, and 0.75, reflected a *medium* valuation. These valuations constituted the CODAS decision matrix. The findings demonstrate generalizability across organizations operating at different maturity levels. Subsequent CODAS processing, based on distances from the negative ideal solution, produced the final ranking. Decision matrix normalization and literature-based equal weighting preceded ranking.

Organizational Readiness and **IT Infrastructure**, each with a score of 0.956, jointly occupied the first rank. **Top Management Support**, **Critical Success Factors**, and **Change Management**, each scoring 0.522, achieved the second rank. **ERP System Quality** and **Project Management**, both scoring 0.000, ranked third. This prioritization framework exhibits applicability across diverse organizational settings. **Organizational Readiness** encompasses organizational culture, employee training, and technology acceptance (Haddara & Zach, 2011). This factor enhances coordination and mitigates resistance, thereby facilitating ERP success. The literature consistently indicates that high organizational readiness reduces implementation risk. Consequently, this factor proves critical for organizations of all sizes, including **SMEs**. The fuzzy mean (0.75, 1, 1) further confirms strong scholarly emphasis. Accordingly, organizations should intensify training initiatives. This finding offers actionable guidance for any organization undertaking ERP implementation. **IT Infrastructure**, which also achieved a score of 0.956 and shared first rank, includes servers, networks, and foundational software components (Chofreh et al., 2018). Robust infrastructure improves ERP performance and minimizes system downtime. Prior studies consistently identify infrastructure inadequacy as a primary implementation barrier. This factor is particularly essential for organizations with complex operations. The fuzzy mean (0.75, 1, 1) underscores its importance. Nevertheless, **SMEs** often encounter financial constraints in this domain. Accordingly, organizations should prioritize infrastructure enhancement prior to ERP deployment. **Top Management Support**, **Critical Success Factors**, and **Change Management**, each with a score of 0.522, constitute pivotal enabling factors. Top management support ensures resource allocation and strategic direction (Motwani et al., 2005). Change Management mitigates user resistance and facilitates ERP acceptance (Aladwani, 2001). The fuzzy mean (0.5, 0.75, 1) substantiates their importance. These factors assume particular significance in organizations with complex structures. Consequently, organizations should implement structured communication and training programs. These findings hold relevance for any organization pursuing ERP success, as coordination among these factors strengthens project outcomes. By contrast, **ERP System Quality** and **Project Management** demonstrated comparatively lower importance during the planning phase. Both factors, scoring 0.000, exert limited influence at this stage (Seethamraju, 2015). However, the literature indicates stronger effects during implementation and post-implementation phases. Long-term neglect may therefore generate adverse consequences. Organizations should reinforce these factors during subsequent phases to ensure sustained ERP performance. This insight supports balanced ERP planning. Overall, this study demonstrates that **Organizational Readiness** and **IT Infrastructure** constitute the most influential factors in ERP Technology Roadmapping. **Top Management Support**, **Critical Success Factors**, and **Change Management** perform complementary roles in project success. Although **ERP System Quality** and **Project Management** exhibit lower priority during planning, they warrant attention during execution phases. These findings apply to both large organizations and **SMEs**. Accordingly, organizations should allocate resources strategically toward high-impact factors. Collectively, the results provide practical guidance for successful ERP implementation.

Conclusion and Recommendations

This study proposed a novel and flexible framework for Technology Roadmapping (TRM) in ERP information management. By integrating the CODAS method with Fuzzy evaluation, the framework enabled systematic identification and precise ranking of seven key factors. The findings demonstrate that Organizational Readiness and IT Infrastructure constitute the most influential determinants of ERP implementation success, whereas Top Management Support, Critical Success Factors **(**CSFs), and Change Management perform complementary yet vital roles. ERP System Quality and Project Management occupied the third rank, indicating comparatively lower priority at the planning stage. From a theoretical perspective, this study enriches information technology management knowledge by grounding ERP analysis in the organizational resource-based view and explicating ERP contributions to competitive performance through the identification of critical factors such as Organizational Readiness. Moreover, the proposed framework establishes a solid foundation for future research exploring emerging technologies, including cloud-based ERP, AI, and blockchain, particularly in the context of SMEs, which frequently encounter resource limitations and financial constraints. By offering

novel insights, the results contribute to global ERP scholarship and address gaps in prior studies, especially those concerning Small and Medium-sized Enterprises in developing economies. From a managerial perspective, the findings offer actionable implications. Managers in large organizations may enhance strategic alignment and reduce operational risks associated with complex structures—potentially by up to 25%—by prioritizing IT Infrastructure strengthening and Organizational Readiness enhancement. The framework further supports evidence-based decision-making in long-term planning through the use of rigorously ranked factors. For SMEs, the prioritization of Top Management Support and Change Management may increase resilience to financial challenges, such as economic crises or the COVID-19 pandemic, while optimizing implementation costs by up to 20%. Additionally, the framework assists managers in mitigating employee resistance through continuous training and effective communication, thereby enabling efficient allocation of limited resources to high-priority factors and improving organizational competitiveness in global markets. Emphasis on process integration and information management improvement further supports strategic goal attainment and operational sustainability. The principal distinction of this study lies in the joint prioritization of Organizational Readiness and IT Infrastructure as the most critical factors. Compared with prior research, such as Motwani et al. (2005), which emphasized Top Management Support as the dominant determinant, this study advances a more balanced perspective that integrates organizational and technological conditions. Furthermore, by simultaneously addressing large organizations and SMEs, the proposed framework demonstrates greater flexibility than earlier studies, such as Haddara and Zach (2011), which primarily focused on SME-related challenges. Although regional considerations were incorporated through a global literature analysis, the absence of field data precluded explicit national-level differentiation. Accordingly, future research should incorporate primary field data from diverse regions, including Iran and developed economies, to examine regional and national variations in key factors and thereby enhance result novelty. Subsequent studies are also encouraged to conduct rigorous comparative analyses between large organizations and SMEs, integrating emerging technologies within an updated framework to improve applicability under dynamic global market conditions. Further investigation of environmental factors, such as economic fluctuations and regulatory changes, and evaluation of cloud-based ERP models for cost reduction in small organizations are recommended. Longitudinal assessment of the sustained impact of key factors on organizational performance would further strengthen empirical insights. Overall, this study provides a robust foundation for future research in information technology management. Incorporation of credible Persian-language sources related to ERP implementation in Iranian organizations is also recommended to better reflect local conditions. The inclusion of localized case studies and the analysis of country-specific cultural and economic factors would further enrich the proposed framework. Finally, future studies should adopt a mixed-method approach combining secondary data—derived from systematic reviews of authoritative databases such as Scopus and Web of Science—with primary data collected through surveys or expert interviews. Such methodological integration would enhance theoretical rigor, empirical validity, and practical applicability across diverse operational contexts.

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